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The Journal of HEREDITY

Sex-Changes in Feather Transplants

(See Page 319)

Burbank's Breeding Methods

Giant Rose Hybrids

Chimeras of Poinsettia and Poultry

Downless Chickens

VOLUME 20 JULY, 1929 NUMBER 7

The American Genetic Association

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IN THIS ISSUE

ROSA GIGANTEA AND ITS HYBRIDS
By H. Cayeux 305

SAINT LUTHER
By O. F. Cook 309

GENETIC AND METABOLIC SEX-DIFFERENCES
By C. H. Danforth 319

THE MORPHOLOGICAL NATURE OF TEOPOD CORN
By Paul Weatherwax 325

DOWNLESS CHICKENS
By A. S. Serebrovsky and S. G. Petroff 331

A RED-TO-WHITE MUTATION IN MAIZE
By R. A. Brink 333

A PINK POINSETTIA CHIMERA
By T. Ralph Robinson and Geo. M. Darrow 335

HAIRY BOLLS AND NECTARIES IN A HYBRID COTTON
By Robert H. Peebles 341

ABNORMAL BRANCHING IN AILANTHUS
By P. A. Davies and Edna Bennett 349

OTHER GIGANTEA HYBRIDS 308

TUBERCULOSIS OF MEXICANS IN CHICAGO 308

CORRESPONDENCE 322
Corrections in Serebrovsky abstract.
Notes on Mosaic Fowls.

BISON IN ALASKA 324

BOOKS RECEIVED 330

WATCHFUL WAITING IN EUGENICS 339

MAKING THE MOST OF THE MICROSCOPE 349

COMING

Human Heredity

A collarboneless family — Inheritance of artistic ability—Birth-rate of college graduates and their non-collegiate brothers and cousins—Inheritance of bent fingers—Indian-Nordic hybrids.

Plant Heredity

Hybrids between apple species—The double pummelo—The giant cactus as a food plant—Earliness in barley hybrids—A giant mutant freesia—Cabbage-radish hybrids—The Totem Pole Rose.

Animal Heredity

Zebra-horse hybrids—The Siamese cat—Breeding hen-feathered Leghorns—Inheritance of trail-barking propensity in dogs—Inheritance in bantam crosses—Dairy-cattle improvement illustrated—Quadruplets in sheep—Atavism in Jersey cattle.

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THE BELLE PORTUGAISE ROSE

Frontispiece

A hybrid of the giant tropical rose, *Rosa gigantea*, with the tea rose *Souvenir de Leonis Vicnnot*. *Rosa gigantea* produces in one year stems 24 to 30 feet long, and its flower buds are often four inches long. The hybrid has retained much of the vigor of its wild parent, and from its other parent it has inherited increased hardiness and free-blooming characteristics. Photographs courtesy of the Coolidge Rare Plant Gardens.

ROSA GIGANTEA AND ITS HYBRIDS

H. Cayeux*

Director des Jardin et Promenades de la Ville der Havre, France.

THIS magnificent species, introduced almost forty years ago, seems to have been cultivated some time before producing its large and beautiful flowers, for it was not until April 1896, when I was director of the Botanical Gardens of Lisbon that it bloomed for the first time in Europe. The following year, a plant received from the Botanical Gardens of Kew several years before, produced a number of roses at the home of Baron Soutellinho at Porto (Portugal).

Up to this time, *Rosa gigantea* had been considered, and rightly, as a shy bloomer. The reason for this was that all the specimens then cultivated came from seed which developed so vigorously as to produce stems from 8 to 10 meters (24 to 30 feet) long in a single year. As a result of this, they bloomed with difficulty.

Since then grafting has been resorted to with satisfactory results. By using only flowering branches for grafting wood, the abundance of the blossoms has been considerably increased—so much so, that every plant propagated by cleft grafting upon *Rosa indica,* for instance, produced numbers of roses as early as the second year.

Plants which are still more generous bloomers can be obtained by top grafting *Rosa gigantea* in the same manner upon tea-roses which have been grafted on the Eglantine rose. Plants thus obtained, cultivated in large pots, make a bushy growth and flower abundantly, although attaining a height of more than 1.20 to 1.50 meters (46 to 58 inches). I will add that formerly I used this method of cultivation in order that I could have at my disposal small plants, which permitted me to prepare the flowers easily before being hybridized, without having to use a stool or ladder.

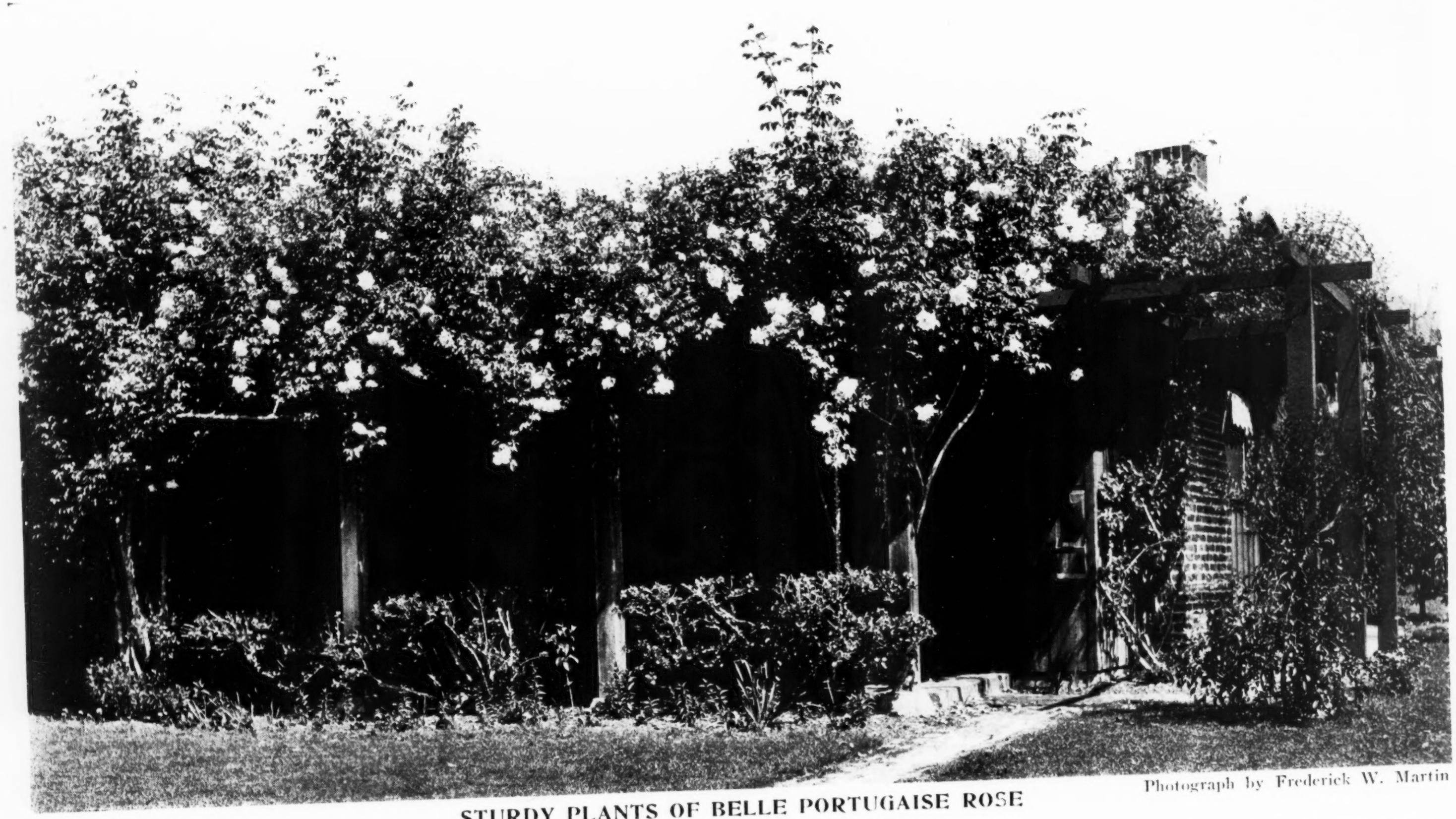
On account of the dimensions of the flower, which normally reaches from 12 to 13 centimeters (4½ to 5 inches) in diameter, and the more or less deep yellow coloring of its very long bud, *Rosa gigantea* at once attracted my attention, and I thought that it would be capable of producing interesting hybrids. It was, therefore, with this idea that I tried a large number of pollinations of this species, using the pollen from various varieties of tea roses and hybrid perpetuals.

Experience has since taught me that the best result is obtained by using pollen of the tea rose. There seems besides to be more affinity between this and the *R. gigantea* than there is between it and the hybrid perpetuals. In every case the influence of the father in these crosses acts in a satisfactory and dominant fashion.

Early Hybrids

Although the first flowering of *R. gigantea* took place in 1896, I did not begin the hybridizations until 1898, when I obtained some seeds which, planted in 1899, produced plants whose first flowers did not appear until 1903, four years later. I confess that this period of four years of waiting seemed to me very long; but there is nothing surprising about it if one considers that the seedlings produced by *R. gigantea* are so vigorous that they must reach a considerable development before deciding to bloom. It was from this series that I had the satisfaction of seeing the beautiful *Etoile de Portugal* appear, which performs wonders when cultivated in a climate where orange trees grow.

*Translation by Mrs. Franklin Harris.



Photograph by Frederick W. Martin

STURDY PLANTS OF BELLE PORTUGAISE ROSE

Figure 1

With flowers up to six inches in diameter and canes in proportion, truly the Belle Portuguaise is a worthy descendent of the Giant Rose.

I then tried the reciprocal cross, that is to say using *R. gigantea* as father, with the aim, above all, of obtaining hardier plants, capable of cultivation in a colder climate, thanks to the use of the varieties employed as mother plants.

From these diverse crosses a series of interesting forms has appeared, among which is found the magnificent variety "Belle Portugaise."

The first hybrids of *R. gigantea* were grown under the skies of Portugal. They came from two different sources, according to whether the latter served as mother plant or as pollen bearer, and may be classified in the following manner:

1st. *Rosa gigantea* on tea.

2nd. Tea on *Rosa gigantea.*

Descending from the first cross, the variety *Etoile de Portugal* is the product of *Rosa gigantea* × *Reine Marie-Henriette.* This plant bloomed for the first time in the Botanical Gardens of Lisbon in 1903. It is of luxuriant growth and seems to have inherited from Reine Marie-Henriette its great abundance of flowers. The elongated buds are often borne by twos or threes on the same flower stalk. The blossom is large, full and fragrant, of a lustrous carmine rose color, shaded to yellow at the base of the petals, which become a lighter color when in full bloom. It should be grown in a temperate climate if one wishes the plant to reach its maximum development and produce in abundance its masses of flowers, of such brilliant and delicate coloring.

The Reciprocal Cross

The second cross, that is to say, the tea rose × *R. gigantea*, produced several very excellent and very beautiful hybrids, chiefly characterized by their soft coloring, their great profution of blooms, and their greater resistance to cold. Among these we may especially note:

1st. *Amateur Lopes*, from *Mme. Berard* × *R. gigantea.* Flower very large and full, pale salmon, washed with rose-lilac at the tips of the petals. A very floriferous plant of average vigor.

2nd. *Belle Portugaise,* from *Souvenir de Leonie Viennot* × *R. gigantea.* A large and beautiful rose of very delicate coloring—shell pink touched with salmon. The very long buds reach a length, sometimes, of 10 cm. (4 inches), especially when they are produced at the ends of vigorous branches. The flower, when completely open, may measure from 15 to 16 centimeters (6-6½ inches) in diameter. Grown in a temperate climate, *Belle Portugaise* attains a great development and is literally covered with its large blooms. It seems to have inherited the great luxuriance possessed by the mother plant, *Souvenir de Leonie Viennot;* moreover, it is able to produce fertile seeds, and might thus be very usefully employed in hybridization.

3rd. *Dona Palmira Feijao,* from *Souvenir de Leonie Viennot* × *R. gigantea.* Flower large, very full, shell pink in the center, the outside of the petals bright carmine. Very brilliant coloring.

4th. *Lusitania,* from *Souvenir de Leonie Viennot* × *R. gigantea.* Flower large, very full, yellow washed with carmine; bud very long. Plant very floriferous.

It is recommended that these very vigorous plants be used in gardens for covering high walls or trellises, but they do wonders in decorating pergolas and even better when planted by themselves on lawns, provided always that sufficient space is afforded for them to attain their normal development. Under these conditions, the hybrids of *R. gigantea* present plants of the highest ornamental interest, giving abundant blooms each year. I cannot recommend their cultivation too strongly to connoisseurs of roses; certain as I am that they will give complete satisfaction.

Figure 1

With flowers up to six inches in diameter and canes in proportion, truly the STORY PLANTS of the Giant Rose. The Belle Portugaise is a worthy descendent of the Giant Rose.

Other Gigantea Hybrids

IN the American Rose Annual for 1924 Mr. Alister Clark records a few of his experiences in crossing *Rosa odorata gigantea*. For Victoria, Australia, the enormous growth of this plant is no particular disadvantage, but it was not for this characteristic as much as for its disease resistant foliage and its obvious suitability for his climate, that he valued it and wished to use it as a parent of a new race.

Not all of the parentages are reported, but most of the seedlings are of two classes, direct crosses in which *Rosa gigantea* was the seed parent, and secondary crosses in which these seedlings are the seed parents. Flying Colours, single light red; Harbinger, single soft pink; Kitty Kininmonth, semi-double, pink; Squatter's Dream, semi-double to saffron yellow represent direct crosses. Lorraine Lee, double rosy apricot-pink; Mrs. Frank Guthrie, semi-double flesh color, are examples of the second group. Golden Vision, Maréchel Niel × *Rosa gigantea*, semi-double yellow fading to white is the only seedling reported in which *gigantea* appears as a pollen parent. Undoubtedly there are other seedlings from this type which have not yet been reported in this country.

B. Morrison.

Tuberculosis in Mexicans in Chicago

Although the Mexican population in Chicago is only about 7,000 persons in a total population of about 3,000,000, the tuberculosis death rate among the Mexicans is so much higher than for the general population that it constitutes a problem. Sixty-eight Mexicans died in Chicago of tuberculosis in 1927, making a mortality rate of 971 per hundred thousand, whereas the total tuberculosis rate of Chicago, according to Dr. Benjamin Goldberg, secretary of the board of directors of the Municipal Tuberculosis Sanitarium, is 82.7. Among the sixty-eight Mexican deaths in 1927 were fifty who were Mexican born, and of these 64 per cent died as charity patients in Cook County Hospital. In 1910 the Chicago Mexican population was only 102. What a large Mexican population will mean in health in future years may be foreseen by considering the tuberculosis situation in the present negro population, of whom there are about 170,000. It has been found necessary, Dr. Goldberg says, to devote three of the eight tuberculosis dispensaries, or 37 per cent of the entire tuberculosis facilities, to the care of tuberculous negroes. Mexicans living in cities are said to be more susceptible to tuberculosis than the negro. An increase in the Mexican population, therefore, up to 150,000 would practically monopolize all of the remaining five dispensaries. The operation costs for a tuberculosis dispensary averages about $104,000 a year.—*Jour. Amer. Med. Assoc.*, June 1, 1929.

SAINT LUTHER

A Burbank Cult, with an Account of and his Wonder-Working Methods of Plant Breeding

O. F. Cook
Bureau of Plant Industry

THE prospect of a Burbank cult is strongly suggested in a little book by Frederick W. Clampett, issued by the MacMillan Company.* An introductory note and an epilogue are furnished by David Starr Jordan, who states that Dr. Clampett "has been for over forty years a clergyman of the Protestant Episcopal Church, and has long been honored as one of its wise and liberal representatives." The attestation of Burbank's sainthood by Dr. Clampett could hardly be more explicit.

> For love, for unselfishness, for great services to humanity, for kindness, for sweet reasonableness and tolerance, for joyousness of living, for simplicity, for the splendor of his brilliant physical, mental and spiritual powers, pureness of life and character, he stands alone among the many thousands of other men I have met in a public life of over forty years. (Pp. 26-27.)

> In his attitude toward things spiritual I have never been in contact with a man so free from the bondage of tradition and the blinders of prejudice. He championed no system, held himself aloof so as to be free to pass by all structural theology on the other side and seek the truth, for truth's sake alone, with all the single-minded intenseness of his nature. (P. 27.)

> Things that would stagger the average man he took as a matter of course. Fearlessly he marched forward in his quest for truth, as if the supreme demand of things spiritual was whole-hearted response to the precept: "Prove all things; hold fast that which is good." (P. 25.)

> No man in history lived so long with Nature or gave to the world, as a result of such close companionship, so many rich and varied blessings. For more than sixty years his mind was concentrated on Nature's possibilities, intent on learning her stories. To this study he brought naturally acute powers of observation, infinite patience and the most delicate discrimination in analysis. It can readily be seen how these qualities would develop and become perfected through the years. Alone amid the silences of Nature, he worked over the millions on millions of plants that passed through his hands. Profitable results of any kind depended upon an ability to detect in a flash variations that would pass most observers unnoticed. (P. 26.)

Burbank was born at Lancaster, Massachusetts, March 7, 1849, and died at Santa Rosa, California, April 11, 1926. He was of English and Scotch ancestry, the thirteenth child of a family of fifteen, and his mother lived to 97. He attended "a local academy" and took "a course in medicine," presumably by reading books in a local practitioner's office, as the custom was in those days. Interest in plants was aroused by an older cousin "Professor Levi Burbank" and by contacts with Louis Agassiz and Ralph Waldo Emerson. Also books by Thoreau, Humboldt and Darwin are credited with formative impressions. Emerson and Thoreau lived at Concord, only a few miles east of Lancaster. Working in a plow factory, market-gardening and seed-raising, were Burbank's early occupations. The first exploit in plant breeding was in 1873, the production of the "Burbank potato," a seedling raised from a "potato ball" of "Early Rose."

In 1875 Burbank migrated to California and arrived at Santa Rosa "with ten dollars, ten potatoes, and a few choice books." Many privations were faced in the early years, but eventually the plant-breeding operations were established on a

*Luther Burbank, "Our Beloved Infidel," "His Religion of Humanity," by Frederick W. Clampett. (Price $1.50.) The Macmillan Company, 1926.

large scale. He married very late and had no children or other distractions from his plant work. Hundreds of new fruits and other plant novelties were discovered or bred and supplied to nurserymen and seed-growers. The richest agriculture in the world was developed in the half-century of Burbank's life in California, and he became the most prominent citizen of the Golden State. According to Clampett, "Luther Burbank is the most widely known and least understood of modern scientists," and Clampett quotes also a statement by de Vries: "Luther Burbank was the greatest breeder of plants the world has ever known. The magnitude of his work exceeds anything that was ever done before."

Clampett presents Burbank as a religious reformer who called himself an "infidel" only "'as a challenge to thought," in order to obtain a hearing for his religious convictions. The author reflects on the weakness of "structural theology" and is convinced of the need of a human-interest gospel like Burbank's. It is notable that a clergyman should find so many virtues outside the church, and that a plant-breeder should appear in the rôle of priest or reconciler—a modern Melchisedec, attested by miracles of science.

The beginning of a ceremonial may be seen in the plan reported recently to put Christmas lights in a cedar tree on Burbank's grave, planted at his request. The newspapers do not state that it is a Cedar of Lebanon, but already it is described as a large tree. No doubt it will reach an imposing size and house many birds in its branches. Christmas trees are a remnant of Druidism, and many other plant observances are found among primitive peoples. The ancient Chaldaeans celebrated the pollination of the date palm as a religious ceremony and the Burbankians in southern California may restore the palm ritual.

If Mrs. Eddy was able to start a new religion, why should the same distinction be denied to Burbank, if people rally to his cult? The world needs more devotion to life, instead of obsession with disease and death. An interest in plants leads naturally to an interest in people. Good plants are of no real use or satisfaction without good people to grow, appreciate, and enjoy them. Religion that does not begin by seeing that life is good, certainly is not consistent with the Bible or with any right instinct of humanity. "One world at a time" is not a bad sentiment, except for those who do not know what life is in this world. "Another world were waste of bliss, for those who find no good in this."

Burbank was alive to a world of living wonders, and was inspired by them to belief in new progress for humanity, through better plants and animals, better people, and better education, to permit a larger development of human qualities. Even while he lived, thousands came to see the "Seer of Santa Rosa," and now that he is dead, veneration may be carried to any length. His new faith in humanity, based on his knowledge and love of plants, puts him in line with Saint Francis and others who have loved the world of living things, as well as the world of men. Tradition says that even the birds came to Saint Francis and that he preached sermons to them. The plants grew for Burbank and he found a gospel in the fruits and blossoms. Considering the lilies was his text, and he became the great evangelist of the flowers. Here was a man who seemed to perform miracles with plants, and did not deny it! He even dared to call his products "New Creations."

This figure of speech seems to have been taken literally by great numbers of religious people, so that Burbank's reference to himself as an "infidel" in a newspaper interview, in January 1926, brought on an acute religious controversy. He was overwhelmed with thousands of letters of protest or commendation, tears from the de

vout and cheers from the scoffers, until finally he was persuaded to preach in a church, "to help allay the seething feelings of narrow bigots." Dr. Clampett assisted in handling the religious correspondence of this period, which showed that about 9000 people had been stirred sufficiently by the newspaper reports to take up their pens, or to work their typewriters. The incident shows that the taste for miracles is still strong, and that much religious faith was pinned to Burbank. He did not avoid the responsibility but insisted on replying personally to hundreds of the letters that called for his special interest or sympathy. The extra labor and strain apparently were too much and he died a few weeks later. Thus it may be said that his declining years were sacrificed to his religious convictions —that he was the first martyr to his new gospel.

The Miracle of Life

Life is a miracle not to be denied and impossible to exaggerate, an exalting, engrossing revelation to those who have eyes that can see, and ears that can hear. If religion requires something to wonder at, why forget life? None of the miracles that have been reported or imagined as tests of faith begin to be as wonderful as the facts that we know of life, or more impossible to explain by any existing knowledge from the physical, "material" world.

The microscope shows us the living cells as minute particles of colorless jelly, and these particles not only conduct the highly complex functions of life, but also contain and transmit records of millions of years of previous existence when structure and function were different from the present. This amazing continuity of life, which we call heredity, is well established as a fact, though entirely unexplained. The soft protoplasm is the most durable material, and awaits the great artist who can teach mankind the uses of heredity. Shakespeare claimed that his "powerful rime" would outlast the monuments of princes, but protoplasm survives languages and civilizations. Life already is immortal, and in man is becoming conscious.

Biology is the premier science. Physics and chemistry have had airs of finality which were not warranted, as the recent progress in those sciences has shown. The life process shows that much is still to be learned about physics and chemistry. Looking for absolutes in matter may be as futile as in the world of abstract ideas. "Nature is infinitely complex and therefore we have only to push our experience far enough to find that our physical laws are imperfectly stated, and that our physical models are inadequate."

We need not wait to explain life in physical or chemical terms in order to see that there are different qualities in living things, and that these protoplasmic differences are of first and last importance, the alpha and omega of our existence as human beings, as well as in plant and animal life. Plants are the best field for learning the facts of heredity and appreciating their importance. "How can we understand laws and institutions, religions and customs, without understanding, not merely the nature of the creatures that made them, but the nature of the stuff out of which the creatures are made?"

Selection Determines the Future

The technique of improvement in the field of biology is very simple and obvious, once we are in the presence of the facts. Everything depends on recognizing, preserving and perpetuating the desirable characters, of plants, animals and men. The greatest of all values is in kind, and in keeping to the right kinds. This is ancient wisdom as well as modern science. A Greek philosopher expressed the idea most effectively in three words, *Ethos anthropou daimon*,

but no English equivalent has been found. "Our fashion our fate," may serve as an approach, since nature and nurture, habit and habitat, are all implied in *ethos,* all that goes to the making of kind.

The Darwinians tried to tell us that good characters necessarily would be preserved and increased through an inevitable natural selection, but this is plainly not true. Selection may be good or bad, depending on which characters are preserved. For purposes of civilization and social progress, characters are needed which might not contribute to survival under conditions of primitive barbarism. The continuance of our present civilization may depend very acutely on a wider understanding of selection and other biological factors. The biological equipment of the race must keep pace with the mechanical equipment, or our machines will drag us all to the cities and destroy us. Unless the world is made conscious of the biological factors, other achievements of scientific progress are in vain.

People are different in the same ways that plants are different, and it is of the utmost importance that we learn to recognize and appreciate the differences that exist in plants, animals and people, from the standpoint of selecting and preserving the best. At present we are taught to believe that people are all alike, instead of being led to appreciate the wonderful variety in our human nature. Interest in humanity would no longer be considered as a remote ideal of "altruism," but a direct flesh-and-blood issue for every one of us, were we sufficiently aware of the nature of our own existence.

Burbank made bonfires of rejected plants, which to his neighbors seemed a strange kind of farming, to raise thousands of plants only to destroy them, but life is wasted on a vast scale in the human species. The cities are our human bonfires, and in each generation there is a selection of the more capable young people from the country for the cities to destroy. Our system of education and social pressure is arranged as though the object had been to pull out as many of the good seedlings as possible and pile them up to be consumed. Burbank wrote a book about education that emphasized strongly the necessity of favorable environments for children, and recognized that the country is "the only place that is truly fit to bring up a boy." People who grow up in the country are more likely to exercise and develop the ability that they have than are people who grow up in the city. "No boy or girl should see the inside of a school house until at least ten years old . . . the curse of modern child-life in America is over-education."

Burbank's Special Method

Usually Burbank was described as a "wizard," which was hardly the right word, since he did not work by charms or incantations. Yet he did not disclaim a special "second sight" ability in dealing with plants, and his belief in peculiar powers of discrimination may have strengthened in the later years, after finding that many accredited scientists could not use or appreciate his methods. Even when he tried to explain his procedure and showed examples of plants whose differences were obvious and familiar to him, visitors might still fail to see what he was talking about, and be even more convinced that he was a clairvoyant or a quack.

Though very keen in recognizing differences among his plants, it was not Burbank's habit of mind to formulate the contrasting characters and thus to make himself fully conscious of what he saw. The visual and the verbal recognition are different acts of the mind, and as Burbank commonly performed the one without the other, he could remain somewhat in doubt of the nature of his "special powers." Besides, if the best authorities tell a man that he is a wonder-

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Photograph by Robert L. Taylor

SEEDLING VARIATIONS

Figure 2

The seedling leaves of many plants are more specialized than the adult leaves and often show perceptible differences even in very early stages. Seedlings of the fox-glove for example show many differences in the form, texture and venation of the leaves. Of the two seedlings shown one has short rounded leaf blades, scalloped margins, and long petioles, contrasting with the oblong leaves, nearly entire margin and short petioles of the other plant.

worker, possibly he may be excused for entertaining such an idea of himself.

Burbank's method of selection as applied to trees and perennial plants was in advance of the science of his time, and has not been fully appreciated. The first operation in improving a plant by Burbank's method was to explore the range of variation among the young seedlings in the early stages of germination. Much diversity may be shown in the characters of the cotyledons and the juvenile foliage, which often is very different from that of the adult plants. Series of seedling variations were selected and grown in order to learn the types of seedlings which would give the best promise of desirable variations in adult characters. If it appeared that larger fruits were to be expected from broad-leaved seedlings, quantities of seed were planted and the seedlings gone over to obtain large numbers of broad-leaved plants, to multiply the chances of finding valuable forms.

The destruction of vast numbers of rejects was the feature of Burbank's experiments that greatly impressed the public, but the secret of his success was in the still greater numbers that were eliminated in advance by seedling selection. Other features of Burbank's technique have been well appreciated, notably his extensive use of budding and grafting to determine as quickly as possible the fruiting characters of the seedlings that were rown, but seedling selection was the underlying principle of Burbank's work, and has received little attention, even from those who witnessed his experiments and gave favorable reports.

Jordan says in the "epilogue" of the present book that Burbank "could forecast almost instinctively the future of even a tiny seedling." But it is plain that the millions of worthless stalks would not have been grown to make bonfires if it were known beforehand which of the small seedlings would be the best. A good biological principle was being developed and followed, not a mysterious "instinct." By giving attention to variations in seedling characters, Burbank was greatly increasing his chances of finding variations in adult characters, though he was still taking chances which made it necessary to grow the variant seedlings in as large numbers as possible.

Kellogg also refers to seedling selection by Burbank, but describes a later stage of the process, after the plants had made woody growth and no doubt were beginning to show some of their adult characters. "I have seen Luther Burbank, one of whose special qualifications for plant breeding is an unusual capacity for such discrimination, crawling about on his hands and knees among the thousand little seedlings in a plant bed all derived from a single crossing, and selecting the few that he wishes to live and reproduce themselves, while the others go to the bonfire." Differences of leaves, spines or branching habits were also significant to Burbank, and allowed him to thin out his beds or nursery-rows without waiting for the fruits.

It was only by reducing the numbers of plants as rapidly as possible that the occupation of producing new fruits could be made profitable. Hundreds or thousands of times as much space and labor might have been required to raise all the seedlings to maturity and make the selection on the basis of the adult characters. As compared with depending upon the chances of good seedling trees turning up in woodlots and hedge-rows, Burbank's system for finding his "new creations" was a wonderful advance.

Characters Vary Together

Correlations of particular characters are sometimes found, and no doubt enabled Burbank in some cases to pick good seedlings in advance, even at early stages, but a general

AN EXAMPLE OF SEEDLING VARIATION

Figure 3

Leaves of two seedlings of the Para Rubber Tree (*Hevea brasiliensis*), showing variation in width of early leaves. This is the kind of variation that Burbank used in selecting his seedlings. An examination of many seedlings would show him what might be called the normal range of variation. By selecting seedlings that exceeded this he obtained greater variation in the plants he saved than would have been obtained in a random stock of seedlings.

correlation of variations is also to be recognized, in the sense that changes in one character usually are accompanied by changes in other characters. In other words, variations tend to appear in groups, and may be described as symphanic or syndromic, like the varying combinations of symptoms that show the reactions of different constitutions to the same diseases.

Variations in single characters are assumed in many text-books but in reality are seldom found, and the assumption is misleading, though supposed to simplify the study of genetics. The mathematical explanations are simplified but the biological facts are overlooked. Where one character has been changed, other characters are likely to be affected. One feature may attract special attention, but usually other differences are found when careful comparisons are made. Thus the variations in seedling characters afford a practical indication that variations in adult characters may be expected by raising variant seedlings.

The practice of seedling selection may be described as a use of correlations, though not of the kind that have been the subject of mathematical investigations. If Burbank had stopped to demonstrate the relations that

he believed in, his work as a plant breeder might not have been done. If he was little understood, it was because science was backward in recognizing the facts with which he worked, which are difficult to present or to formulate, so as to convince those who do not have direct knowledge. The diversity of nature still is a closed book, even to many biologists. What Burbank did was simply to explore this diversity in his chosen field, and he did this more competently and extensively than any of his predecessors or contemporaries.

Unquestionably, Burbank saw plants as few others see them, even among those who have special training and standing as plant-breeders. It was this ability to see the plants for himself that enabled him to find so many new forms and gave him standing with many men of science, though others took him for a charlatan. Popular confidence was shaken when some of his most-heralded novelties proved disappointing, like the "Wonderberry" and the "Spineless Cactus," or when he claimed "discoveries" that could not be substantiated, as crossing corn and sorghum, or developing corn from teosinte. He assumed that he could tell the parentage of chance hybrids, taking no account of the enormous extra-parental diversity that commonly appears in the perjugate generations of wide crosses.

No doubt his assurance increased with the success and prominence that he attained, so that he was satisfied with his own opinions even in matters where others had obtained more definite information. To be told of other spineless cacti in the Tropics, or that his cactus grew spines when planted in the desert, did not mitigate his claims. Nor was sufficient allowance made for varieties developed in the genial climate of Santa Rosa, which might behave abnormally in other regions. The Shasta daisy in California is a flower to be grateful for, but disappointed gardeners in other parts of the country have called it "Shyster daisy."

Of course it is difficult to concede the grace of ordinary mistakes to one who seems to be claiming a unique or miraculous power, and especially if such claims appear to be made for advertising purposes. Mistakes and miracles are discordant, conflicting ideas. As long as confidence is unshaken we believe everything; but when the oracle fails we deny or distrust everything. Faith clings to an absolute, and draws strength from objections. A "Devil's Advocate" was considered necessary to the church procedure of canonization. Without the detractors, faith could not be tested and the cult established. It will abate nothing of Burbank's ultimate sainthood to have been treated invidiously, or even suspected and accused by some of his contemporaries. The worst detraction may be that he was a good business man, but even this may be overlooked in the present commercial age. Genius as an advertiser will not be denied him, and he used it to put his plants before the world. The work of Van Fleet, for example, in actual production of useful new forms may equal or exceed that of Burbank, but Van Fleet did not draw the spot-light. He was a shy Burbank.

It is nothing against Burbank or Van Fleet that many of their finest productions may be little used or lost entirely, as we are still in a crude age when only the commercial values are considered. A poor peach that ships well is grown on thousands of acres by people too indifferent to life to grow even a few trees of good peaches for their own use.

The mistakes that Burbank made may even serve in the future to enhance his reputation for devotion to science, by showing that his handicap was greater than he knew. Ignorance may keep us afloat when more knowledge would overwhelm us! We can see that many of Burbank's views were not strictly scientific, but the

scientific inhibitions might have kept him from doing what he did. He was a practicing biologist rather than a theorist or formal investigator, and was satisfied to use the knowledge that came to him in his own work without waiting to have it formulated and explained to others, or even to himself. He worked like an inventor to produce plants, not as a research specialist to produce information. The obligation of keeping complete records for scientific use would have prevented most of the work that led to his practical achievements. A man must have some confidence in himself if he is to hold any course that his contemporaries are not ready to approve, and Burbank's religious ideas are of a piece with his plant work. Projecting his own interest and experience with plants, he looked forward to a world of people who could appreciate his work and share his satisfactions. If he was something of a quack, he was also something of an apostle.

> . . . There are, throughout society, men, and they are generally men of unusual natural powers, who, after gaining a little unassimilated education, launch out for themselves and set up as authorities on their own account. They are, perhaps, the successors of the old astrologers, in that what they seek to establish is some personal professorship or predominance. The old occultism and mystery was resorted to as the most obvious device for increasing the personal importance of the magician; and the chief difference today between a regular physician and a quack is, that the quack pretends to know it all.
>
> Brigham Young and Joseph Smith were men of phenomenal capacity, who actually invented a religion and created a community by the apparent establishment of supernatural and occult powers. The phrenologists, the venders of patent medicine, the Christian Scientists, the single taxers, and all who proclaim panaceas and nostrums make the same majestic and pontifical appeal to human nature. It is this mystical power, this religious element, which floats them, sells the drugs, cures the sick, and packs the meetings.—CHAPMAN, JOHN JAY, "Emerson and Other Essays. 1899, pp. 1223.

The appeal to human nature is what the critics do not understand or forgive, and they ascribe it to a conceit or assurance consciously assumed as a "device for increasing the personal importance of the magician". Burbank was no "pontifical" person, but he was deeply devoted to his work, was sure of what he was doing, and had a convincing, engaging personality. No character and equipment can be so evenly balanced and symmetrically developed as to appear perfect from every angle of criticism. One critic sees weakness where another sees strength. To some writers Whitman was a quack poet, and Lincoln a quack statesman. If Lincoln had not been sacrificed the world had taken much longer to decide his eminent worth.

Imperfections of the vehicle are not considered, once a great service has been performed and appreciated. Rousseau was scarcely more than a vagabond, by his own account, but he had a sensitive spirit and a ready pen, and was able to plant in his writings new seeds of liberty and progress. Rousseau's appeal to human nature had an immense vogue that undoubtedly changed the course of history, and had its effect in a few years. Jefferson's Declaration of Independence would not have been written without Rousseau, and Lafayette would not have come to America to fight in the Continental army. Nor would La Fayette have sent Washington the key of the Bastile, which still hangs at Mount Vernon, the most eloquent gesture in history.

A man who attains eminence challenges the world to an understanding and starts an endless debate. History and biography consist largely of efforts that have been made to explain or discredit greatness. Contradictory theories are elaborated regarding the same personalities. If we who have known Burbank, heard his doctrine and witnessed his work among his plants are unable to reconcile our views, what limit can be placed to credence or controversy in future generations? The world made a path to his door, and Burbank had something to show them!

Fervent disciples can build structures of fame even with less material than the Burbank traditions afford.

Burbank may be hailed as the modern Prometheus who has prevailed with the gods and brought to earth the sacred fire of a new devotion to life. "Him neither fear of the Gods, nor thunder bolts, intimidated, nor portents in the skies, but rather roused the innate courage of his soul, that he should be the first to break down the jealously guarded portals." Announcing new creations sounded like sacrilege to many, as when Franklin dared to fly his kite into the thunder-clouds.

It was a low opinion of the gods that they were jealous of human efforts to understand the forces of nature. To deal blindly and unconsciously with the issues of life certainly is no virtue, but only a remnant of superstition. Blood rites and burnt offerings are of the past, but many still believe that it is a virtue to close the mind to knowledge, and especially to the knowledge of life. It is a great service to humanity to break the spell of ignorance that has clouded our minds in the past.

The romantic career of Burbank may mark a significant change in the progress of scientific agriculture, which may be out of all proportion to Burbank's actual achievement. It is not necessary to believe that Burbank tried to deceive anybody or that he deliberately staged himself as a wizard or a prophet. To go on doing something that others do not understand creates an air of mystery, and doubts may only be thickened by efforts to explain. Burbank took his own way in the world and lived for the most part a solitary life, centered on a special talent and purpose that for many years was not shared or appreciated by any of his local contemporaries. Men who are thus devoted are not afraid to stand out by themselves, alone on the horizon-line of humanity, holding to what they see, though nobody else sees it. The few who are able to make good in such undertakings naturally become the symbols of the new achievement that they represent, whether it is a new idea established in the minds of men, new lands discovered by a Columbus, or new riches in the world of plants. No naturalist or plantsman since Darwin has a tithe of the eminence of Burbank. Many other names, Galton, Mendel, Weismann, Pierson, Bateson, are better known in science, but fame is a public reflection, not an esoteric respect.

As a worker in applied science, Burbank may be placed with other Americans whose originality and resourcefulness have led to notable discoveries, as Franklin, Fulton, Morse, Bell and Edison, but none of these men has attracted a religious following. Another association for Burbank is with poets and nature-writers like Burroughs, Whitman, Thoreau and Emerson, but even in this group the zeal of a religious movement has not been generated. The talent for literary expression was not highly developed in Burbank, but he was more serviceable than many writers. Literature tries to reflect life, but biology means that we go in at the door of a new consciousness and see the world as it is. The discovery of nature is going forward slowly. Only a few hardy spirits have settled and declared themselves at home in the new country.

GENETIC AND METABOLIC SEX-DIFFERENCES

The Manifestation of a Sex-Linked Trait Following Skin Transplantation

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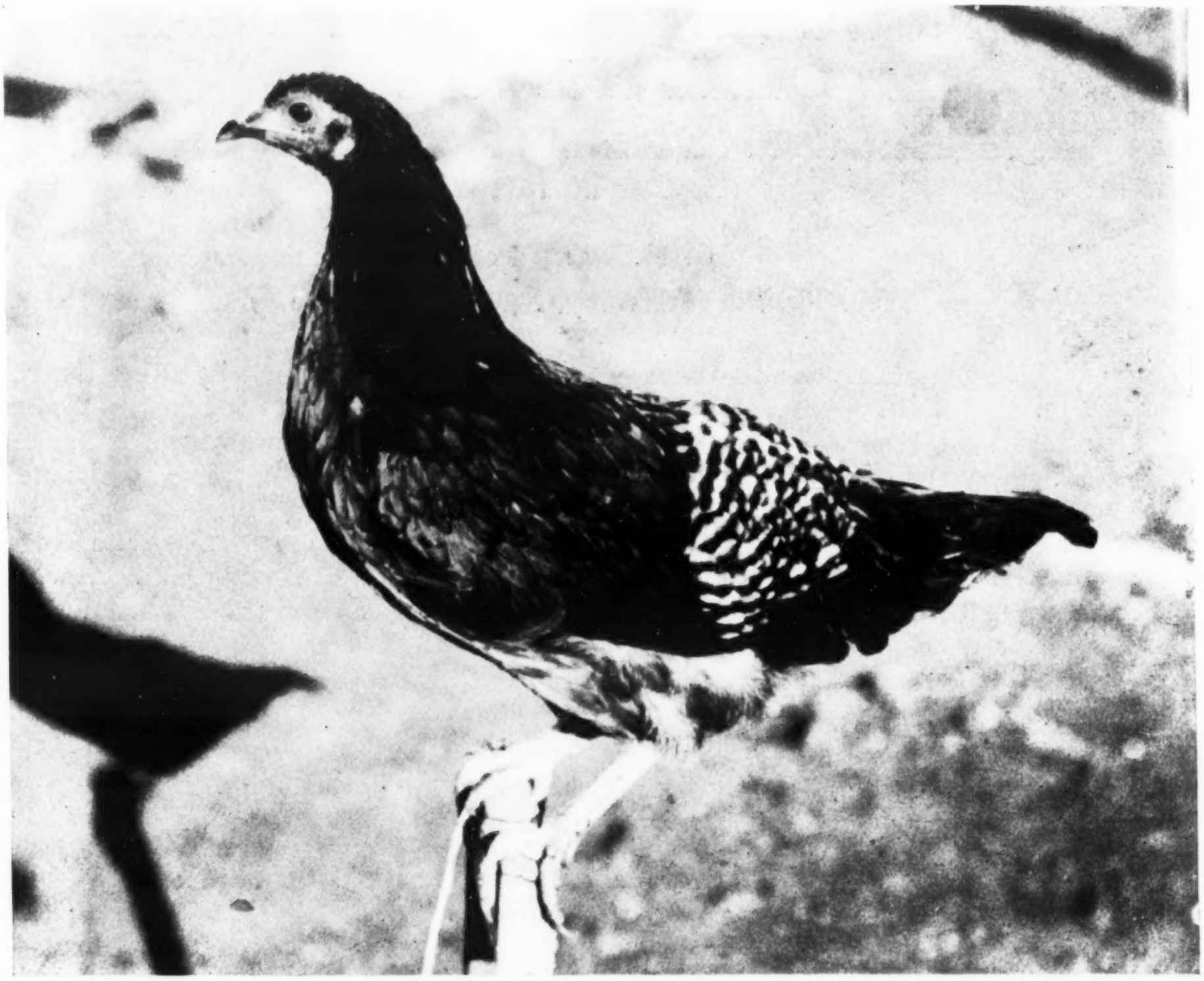
THE essential features of sex-linked inheritance in the fowl established by the researches of Bateson[3], Davenport[6], Serebrovsky[10], Warren[11] are satisfactorily explained, at least to the geneticist, on the basis of the *WZ-ZZ* theory of sex determination in birds.* However, possible cases of sex reversal (Crew[4]) and the weight of the metabolic theory of sex (Riddle[8,9]) would seem to lend a certain importance to any evidence which might bear on the general question of the development of characteristics associated with sex. This is the reason for recording the specimen shown in Figure 4.

This fowl resulted from a cross between a Bantam female and a Rhode Island Red male. When one day old, she received a skin graft from a newly hatched chick whose mother was a Plymouth Rock hen mated to the same Rhode Island Red male. The donor of the graft was lost while young, so that no opportunity was afforded for an anatomical determination of its sex, but there is no reasonable doubt that it was a male. All chicks from the same mating which survived agreed with the results of the classical genetic experiments bearing on the heredity of sex-linked characters in that the males were barred, essentially like ordinary Plymouth Rocks (Agar[1]), while the females were black with a trace of red.

The result of this cross is explained on the ground that neither of the two sex chromosomes, *ZZ*, of the male parent carried the dominant gene *B* for barring, as was shown by the unbarred pattern, while the single *Z* chromosome in the *WZ* complex of the female did carry this gene as revealed by the uniformly barred pattern. Consequently, since a female chick receives the single *Z* chromosome from her father, while a male chick receives a *Z* chromosome from each parent, the males from such a cross as this are barred, being heterozygous for the *B* gene, while the females, lacking such a gene, are not barred. This type of sex-linked trait was made use of by Greenwood[7] in controlling his tests of the possible effects of testicular hormones on chick embryos.

Probably no geneticist would question the validity of Greenwood's reasoning, but it might be argued from the viewpoint of the metabolic theory of sex that in a Plymouth Rock by Rhode Island Red cross the black plumage of the female and the barred plumage of the male are conditioned by different levels of metabolism in the two sexes. There is an adequate genetic refutation of such a suggestion, and the present case furnishes a 'metabolic' one. The female recipient of the graft is herself of fairly uniform color and entirely without barred feathers of her own. The graft which has grown on her back since the day of hatching is covered with large typically barred feathers, clearly shown in the photograph. When it is recalled that at the time the transplant was made none of the feathers that developed later on the graft existed other

*In birds the female has unlike sex chromosomes, designated *WZ*, while the male has two *Z* chromosomes. This is exactly the opposite of the situation in mammals, where the male has unlike sex-chromosomes (*XY*), while the female has two *X*-chromosomes.



ARTIFICIAL SEX-REVERSAL

Figure 4

A pullet from a Bantam × Rhode Island Red cross. The graft on its back from a (male) individual of Barred Plymouth Rock and Rhode Island Red origin, shows the difference in the behavior of a secondary sexual character and a sex-linked character following artificial "sex reversal." The feathers on the graft are round in outline (a secondary sexual character) as a result of the influence of the female host, but barred in pattern (a sex-linked character) because of the origin of the graft from a male. See Figure 5. Had the host been male, the feathers would have been narrow and elongated; had the donor been female, they would have been black.

than as the merest rudiments, it will be apparent that skin of the genetic formula *Bb* can exist, virtually as a part of a female soma, throughout the period of feather development and still produce feathers such as could not have been produced by a sister of the donor. It may be added, incidentally, that as might be expected, pieces of skin from males of the formula *BB* have regularly produced barred feathers when grafted on female hosts.

Geneticists who have questioned the adequacy of the metabolic theory of sex have argued that for a crucial test of sex reversal, individuals should be used in which a clearly defined sex-linked trait is present (Babcock and Clausen[2]). The case here reported in some respects meets this demand, since with reference to the graft, what happened was a complete sex reversal of the rest of the organism. That is, a piece of skin covering a part of the back of a newly hatched male chick suddenly found itself occupying a similar relation to a female chick and continued its development in the new milieu without acquiring the type of coloration that would have developed

A B C D

SEX-LINKAGE AND SEX-CHARACTERS CONTRASTED

Figure 5

At left: Two feathers from pieces of skin grafted on male hosts. *A* from a black female donor, *B* from a barred male donor. The female feather (*A*) has retained its color—a sex-linked character; its shape is typically male—a secondary sexual character. *At right*: Two feathers from the fowl shown in Figure 4, *C* developed from the host's own skin (female); *D* from the grafted male skin. Here the shape of the feather is typically female, but the feather from the male donor retains its barring.

had it been female at the start. This result lends weight to the expectation of the geneticist that a sex reversal occuring subsequent to the zygotic period should be characterized by the sex-linked traits of the other sex.

Although this sex-linked trait was not affected by the transplantation, a *secondary sexual character* was completely reversed, for in this, as in many comparable experiments, the endocrine condition of the host or, what is perhaps the same thing, her metabolic level, did cause the feathers to assume the female form, which, it will be recalled, is quite different from that which they would have had if this piece of skin had developed on its original owner. This is evidence from another angle that sex-linked characters are, in effect, simply racial traits and may be expected to behave in skin transplantation as do other racial peculiarities (Danforth and Foster[5]). In this respect they are clearly contrasted with secondary sexual characters.

The recapitulate, Figure 4 shows a pullet from a Bantam × Rhode Island Red cross. The graft on its back, from an individual of Barred Plymouth Rock and Rhode Island Red origin, shows the difference in the behavior

of a secondary sexual character and a sex-linked character following artificial "sex reversal". The feathers on the graft are rounded in outline (a secondary sexual character) as a result of the influence of the female host, but barred in pattern (a sex-linked character) because of the origin of the graft from a male. Had the host been male, the feathers would have been narrow and elongated; had the donor been female, they would have been black.

This experiment supports the expectation that a trait which is sex-linked should not be influenced, as are secondary sex traits, by sex reversal. It does not raise any question as to the metabolic regulation of sex nor suggest a doubt as to the fundamental compatibility of the metabolic and chromosome theories. But it does serve to emphasize again the value of sex-linked traits, in conjunction with ordinary sex characters, as indicators in experiments designed to study sex reversal.

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CORRESPONDENCE

Corrections in Serebrovsky Abstract

IN a letter just received from Serebrovsky, he asks me to transmit to you the following note for publication in the Journal as a reference to my abstract of his paper on the "Genetics of Leg Feathering" in the March, 1929, number:

"The 'Genetics of the Domestic Fowl' required three years for printing, 1923-1926, and some of the tables were corrected according to new data which accrued while the manuscript was passing through the press. Consequently, in some places the text and the tables do not agree. All of the numbers in the table at the bottom of page 114 (Journal of Heredity, Volume 20) are correct, as well as the percentages calculated from Table II. The percentages calculated 'from the text are based on fewer individuals, and should be replaced by the percentages as calculated from the table. In the table at the bottom of page 116 (Journal of Heredity, Volume 20) in the first line instead of 38 and 23.6, should be 28 and 33.6. The correct numbers in the last line of this Table should be 12, 43 and 33. On page 118, 15th line, at the right, totals of 65:20 are correct instead of 95:17, the last total being due to typographical errors in the original table."

Columbia University. L. C. Dunn.

A Note on Lambert's Mosaic in the Fowl

IN a recent number of this JOURNAL (20: 167-169) Dr. W. V. Lambert has described a most interesting case of an animal mosaic in which a fowl was white-skinned on the left half of the body and yellow-skinned on the right. He considered the most plausible explanation of the abnormality to be that it arose from non-disjunction, at an early cleavage, of the pair of chromosomes carrying the genes for yellow or white skin colour. This assumption presupposes that the bird was heterozygous for skin colour. The evidence from two similar cases suggests that his alternative explanation,—that of a gene mutation—is somewhat more likely to be the correct one.

If it were a case of non-disjunction, one would expect that in addition to the factor for white skin, the chromosome lost from the cell giving rise to the yellow side would also carry other genes. The loss of some of these, particularly those affecting the size of the whole organism or any part thereof, would also be expected to be shown as well as the absence of the dominant gene for white skin. It would be expected, therefore, that the yellow half would be smaller than the white side or would be in some respects disproportionate.

Exactly such a case has recently been described by Crew (*Jour. Genet.* 20: 179-186). A male fowl from a mating of light Sussex female × Rhode Island Red male (and therefore heterozygous for white and yellow skin) was found to be not only yellow in one leg and white in the other, but also to have bones distinctly smaller on the yellow side than the corresponding bones on the white side. The difference in size between the two halves of the body was almost equal to that normally existing between males and females, although some bones were more affected than others. All these facts are in accord with the explanation suggested by Crew that the condition arose from non-disjunction of the chromosomes carrying not only the gene for skin colour but also enough size factors to produce the marked lateral asymmetry of the skeleton.

Somewhat similar is the case described by Mackin (*J. Exper. Zool.* 38:355-368) in which a gynandromorph fowl had not only testicular tissue on the right side and ovarian tissue on the left, but also differences in size between bones of the right and left limbs which the present writer has shown (*Poultry Sci.* 8:202-218) represented very closely the normal sex dimorphism in the appendicular skeleton of the fowl. From this case, apparently a true gynandromorph, it was evident that the loss of the sex chromosome from one side also meant the loss of those size factors which normally bring about the differences in size between male and female skeletons.

These two cases indicating a relationship in the fowl between chromosome aberrations and size disturbances are in accord with our knowledge of modifications in size occurring in polyploid plants and animals and in cases of gynandromorphism in insects. Crew's case is quite consistent with the view that early non-disjunction of the chromosomes carrying the gene for yellow or white skin colour is associated with marked size disturbances. Lambert makes no mention of size differences between right and left sides of his mosaic, nor are any evident from the photograph.

In view of these facts, it seems more likely that this abnormality arose from a mutation in the skin colour gene at some time in early cleavage. From Lambert's description and from the fact that the earlobes appear more completely white than would be expected in a hybrid between a Leghorn and any white-skinned breed (practically all of which have red ear-lobes) it appears most probable that the fowl was a Leghorn and therefore homozygous for yellow skin. If such were

the case the mosaic represents a dominant somatic mutation (from *ww* to *Ww*). However, as Lambert points out, if the fowl were heterozygous for skin colour and a recessive mutation had occurred in the *W* gene, the same effect could have been produced.

The similarity and the difference between Lambert's and Crew's cases—both having lateral asymmetry with respect to skin colour, but only one case exhibiting irregularities in size—suggest that the presence or absence of such irregularities should be a valuable aid in distinguishing between animal chimaeras resulting from nondisjunction of chromosomes and those arising from factor mutations in somatic cells, where either phenomenon has occurred at an early stage of ontogeny.

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Bison in Alaska

The introduction of buffalo into Alaska is an experiment that is being watched with much interest by wild-life conservationists. Twenty-three of these animals were shipped from the National Bison Range, Montana, to the Territory by the Alaska Game Commission in June, 1928 through an appropriation made for the purpose by the Territorial Legislature. Nineteen of them were liberated near McCarty, Alaska, and four were held at the Reindeer Experiment Station of the Biological Survey of the U. S. Department of Agriculture at Fairbanks for experimental purposes.

In a recent report to the Biological Survey, L. J. Palmer, in charge of the reindeer station stated that up to January 9 the buffalo were located on Jarvis Creek, not far from where they were liberated, and were feeding to a large extent on wild vetch. They seem to have adapted themselves to the country, he said, and to be doing well. On February 18 the herd was reproted on Clear Water Creek, 9 miles from McCarty, a stream that has open water throughout the winter and a good growth of brush and grass. The Alaska Game Commission has hay stored at McCarty for feeding the buffalo if necessary, but up to mid-February the animals were finding sufficient food and were in good condition, although there had been some unusually heavy snowfalls.

The buffalo retained at the reindeer station are each fed at the rate of 15 pounds of hay a day, and are in excellent condition—round and fat. The winter has been unusually mild at the station, but during one brief period when the temperature ranged from 30 to 40 degrees below zero with high humidity—it was noted that the animals were covered with hoarfrost, and as soon as they finished feeding at the corrals each morning, they would immediately seek an upper sheltered hollow in the middle of one of the pastures or the top of a warmer adjoining ridge. During warm weather the buffalo remain near the feed troughs at the corrals. On the range, when not grazing, they seek shelter in the forest.

THE MORPHOLOGICAL NATURE OF TEOPOD CORN

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Indiana University

A PECULIAR hereditary anomaly of the maize plant has been reported by Lindstrom under the name Teopod.† This is of interest not only as one of the few *dominant* variations from the usual nature of the plant, but also because of its striking appearance and the large number of more or less independent parts affected. What is known of its history indicates that it originated recently in a variety of ordinary field corn. Lindstrom regards it as improbable that it has resulted in any way from crossing with teosinte. Although self-pollination is not easily accomplished either artificially or in the field, he gives convincing evidence that the entire aggregation of aberrant characteristics is inherited as a unit.

Since its first appearance the plant has been propagated by open pollination in the field, and, because its pollen does not naturally become functional, descriptions are based upon heterozygous individuals. The writer secured seed of this variety from Lindstrom and has had plants under observation in the field for three seasons. Since many striking features were not included in Lindstrom's description, it is thought that a more detailed account will be of interest.

It is difficult to give any general description of the mutant because many of its characteristics are inconstant. It may be said, however, that most of its peculiarities are visibly similar to the various anomalies that have been brought out in maize in recent years by inbreeding. In the manner of branching, and in the appearance of the pistillate branch the plant resembles teosinte. The ear resembles that of pod corn. It was because of the combination of these characteristics that the mutant was named *teopod*. The following characteristics are relatively constant, occurring in practically every plant that shows any phase of the anomaly:

1. The plant branches freely at the base, much in the same way as teosinte or as some of the varieties of maize ordinarily regarded as primitive.

2. The leaf blades are long and slender, particularly those near the top of the plant. (Figure 6.)

3. The terminal inflorescence (Figure 6) is often a simple spike-like raceme, covered with long bracts, in whose axils the spikelets are borne singly or in pairs. In the axils of the lowest bracts the pairs of spikelets are often replaced by short spikelet-bearing branches of various types.

4. Between the pistillate branch and the terminal inflorescence the number of nodes of the main culm is greatly increased, and the leaves are clustered in short spirals or even in whorls. At the same time the culm has a zig-zag form similar to that described in connection with another mutation.‡ The "husks" enclosing the ears, particularly the terminal one, are also greatly increased in number. In a few ears selected at random actual counts showed as many as 65 to 75 husks. The large number of leaves on the main stem and on the ear-bearing branch can better be explained by assuming an increase in the number of nodes rather than an increase in the number of leaves at

*Publication No. 35 of the Waterman Institute for Scientific Research, Indiana University.

†*Journal of Heredity* 16:135-140. 1925.

‡EYSTER: *Journal of Heredity*, 11:349-357. 1920.

TERMINAL INFLORESCENCES OF "TEOPOD"

Figure 6

Each is the homologue of the ordinary tassel.

PORTION OF A TEOPOD PLANT WITH THREE BRANCHES

Figure 7

Each bears one terminal and several lateral "ears." Each of these three branches is the equivalent of an ordinary ear, together with the branch that bears it.

BRACTS PRODUCE "PODDED" APPEARANCE

Figure 8

An "ear," showing the large bracts subtending pairs of grains and giving the ear the "podded" character. In ordinary pod corn the enlarged glumes and lemmas give the same appearance to the ear.

each node. The expression "proliferation of leaves," as used by Lindstrom and by others in speaking of the husks of the ordinary ear, is ambiguous, or at least indefinite.

5. The pistillate shoot may bear small ears at several of its nodes, as well as the one at its end, which is of about the same size as the lateral one (Figures 7, 8).

6. The bracts, which are present as rudiments below the pairs of spikelets in the normal plant, are well developed in this mutant. Sometimes they are as much as five or six inches long and have well-developed blades. In the staminate inflorescence they enfold the spikelets, and they are almost always so long that the stamens are not exserted at flowering (Figure 9*A*). Because of this, the pollen cannot escape, and a teopod plant seldom becomes the male parent of a new individual. In the ear (Figure 8) the corresponding bracts each subtend from one to four grains, which are produced in a pair of spikelets. It is mainly to them that the ear owes its "podded" appearance, and less often to enlarged glumes and lemmas as in ordinary pod corn.

Many other characteristics such as the following are less constant, occurring in only a part of the spikelets of any one plant, or being more pronounced in some individuals than in others:

1. In both inflorescences of almost any plant may be found various degrees of sexual modification between monoecism and monoclinism.

2. A pistillate flower may have one or all of its rudimentary stamens replaced by carpel-like structures bearing long silks with normal stigmatic hairs (Figure 9*H*). This suggests the condition seen in some "defective" types.*

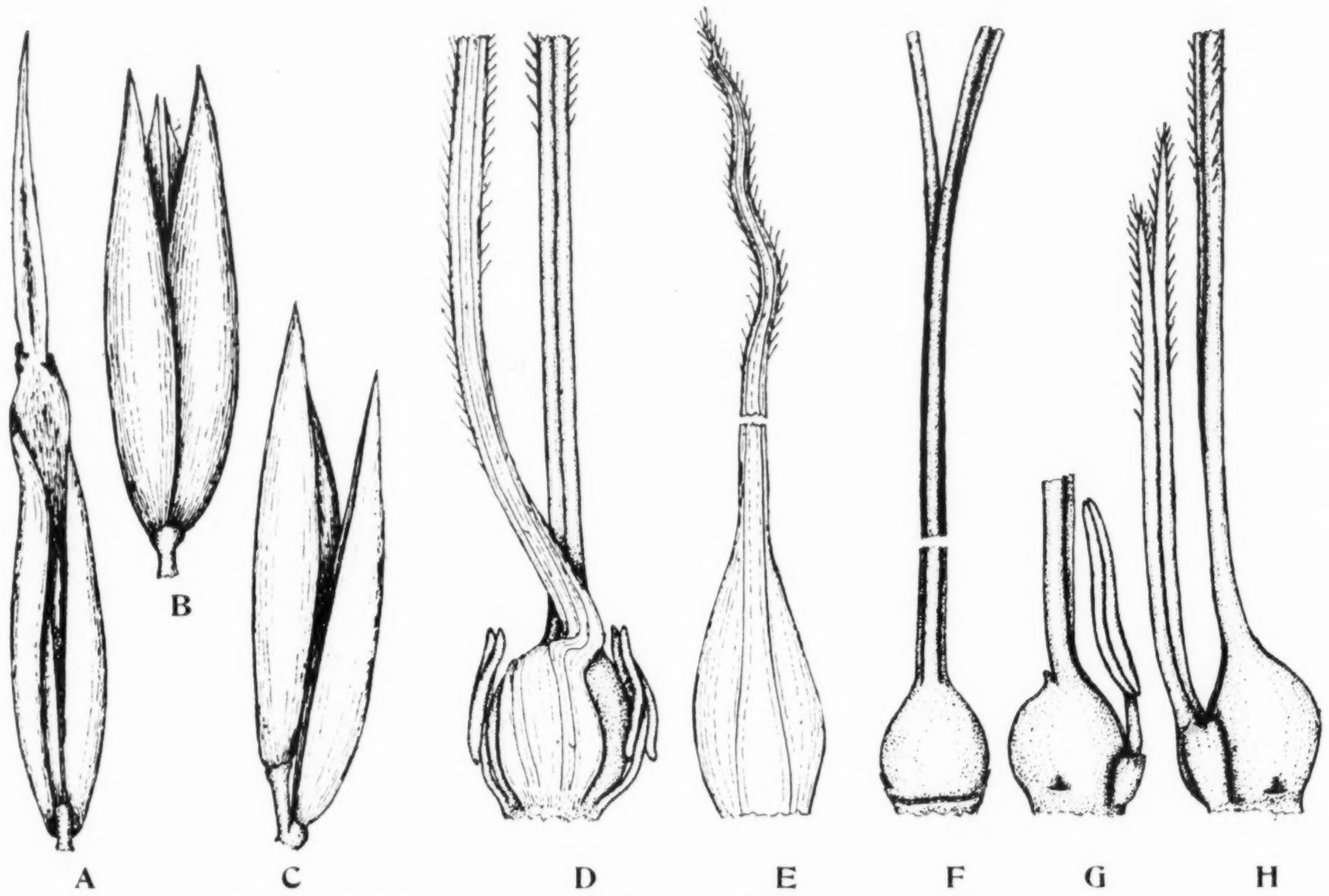
3. The lower flower of the pistillate spikelet may develop a grain, as in Country Gentleman sweet corn. This has been found to be the correct explanation of all cases examined where more than two grains are present in the axil of any one bract on the ear.

4. The style is sometimes three-parted, the three parts being united in various ways for all or only a part of their length (Figure 9*F*). This is in accord with the theory that the grass pistil is tricarpellary.

5. The lemma or the palea may be elongated into a hairy, style-like awn having one or two vascular bundles (Figures 9 *D-E*). These are not the homologues of true styles, however, for the hairs that cover them are the same as the unicellular vegetative trichomes found on various other parts of the plant, rather that the multicellular hairs of the true stigma.

It seems almost certain that a more extended study of teopod plants grown under different conditions would reveal many more anomalies incapable of being included in the above categories, but still a part of the genetic unit involved.

*WEATHERWAX: *Bull. Torrey Club* 52:167-170. 1925.



MODIFICATIONS OF THE FLOWER AND SPIKELET

Figure 9

A to *C*, pairs of staminate spikelets. The pair shown in *A* are enveloped in the leaf-like subtending bract. *D*, pistillate flower with the two lateral stamens well developed, and with the palea bearing a long style-like awn; *E*, a lemma with a style-like awn; *F*, a three-parted style; *G*, pistillate flower with the dorsal stamen well developed; *H*, pistillate flower with the dorsal stamen replaced by a pistil-like structure.

When the entire mutation is analyzed, its elements are found to resemble certain characters which have been isolated singly by inbreeding. Here a single dominant mutation produces a large number of diverse characteristics, many of which are known to occur separately as recessives.

Although the variation is visibly most striking, and doubtless a matter of significance in the plant's natural welfare, it is really a quantitative, rather than a qualitative matter. No new structures are involved. The difference between it and the normal plant is one of degree of development of parts present, in functional or rudimentary form, in any corn plant. This provides a basis on which to consider the genetic nature of the mutation.

As the plant develops from the seedling stage toward maturity, there are laid down, in different parts, almost innumerable primordia which are doomed never to develop into functional organs; and the adult form of the whole plant depends upon an orderly and timely differential suppression among these primordia. Stamens are suppressed in female flowers, and pistils in male flowers; one possible style is suppressed in the pistil; all but one or two possible pistillate branches are suppressed, etc. The consistency with which this extensive suppression ordinarily takes place suggests a somewhat fixed set of regulating influences back of it. A mutation affecting one of the organs singly might be regarded as a failure of one of these influences, and we might be able to establish its locus in the chromatin, but the gene concerned in one of these single recessive changes could not well be identical with the one responsible for the dominant teopod complex. It seems better to postulate for the latter the

positive introduction of an influence having much the character of a master key which interrupts or deranges many of these suppressing influences, leaving a condition of uncertainty as to the degree of development of the parts ordinarily suppressed.

Books Received

BOOKS are acknowledged in this column as received, and such acknowledgment must be regarded as sufficient return for the courtesy of the sender. As far as space permits, books that contain material of special interest to the readers of the JOURNAL *will be reviewed in later numbers.*

YOUR FAMILY TREE: Being a glance at Scientific Aspects of Genealogy, with a variety of illustrative examples from the lineage of families prominent in America and Great Britain. *By* DAVID STARR JORDAN and SARAH LOUISE KIMBALL, Leland Stanford Jr. University. Pp. xi+346. Price $3.00. D. Appleton & Co., New York, 1929.

CHEMISTRY IN MEDICINE, A cooperative treatise [37 distinguished authors] intended to give examples of progress made in medicine with the aid of chemistry. Edited by JULIUS STEIGLITZ, Professor of Chemistry, University of Chicago. Pp. xxi+758. Price $2.00. The Chemical Foundation, New York, 1929.

The genes are believed to be chemical in their action, so that this excellent treatise on the effects of chemical compounds on the human organism should have a wide interest to students of heredity. An inspiring book.

THE MODERN BABY BOOK AND CHILD DEVELOPMENT RECORD, by JOHN E. ANDERSON and FLORENCE L. GOODENOUGH. Pp. xi+398. The Parents' Magazine and J.B. Norton Co., New York, 1929.

A complete record of bringing up the baby—from birth to the sixteenth year. We fear the purchasers of this volume will have to limit themselves to one child or retain a nurse-secretary to keep the record up to date.

BIBLICAL ANTHROPOLOGY, compared with and illustrated by the folklore of Europe and the customs of primitive peoples, by H. J. D. ASTLEY. Pp. 262. Oxford University Press. 1929.

Cold comfort for the Fundamentalists.

THE PSYCHOLOGY OF INDIVIDUAL DIFFERENCES, by ROBERT S. ELLIS, professor of psychology in Colorado College. Pp. xxiii+534. Price $3.50. D. Appleton and Co., New York, 1929.

Why we behave like ourselves. It is much superior to the widely circulated and often quoted *Why We Behave Like Human Beings* that we reluctantly predict a very small sale.

PROBLEMS OF INSTINCT AND INTELLIGENCE, by MAJOR R. W. G. HINGSTON. Pp. xv+296. 33 line drawings. Price $3.25. The Macmillan Co., New York, 1929.

Why ants, etc., behave like insects—instinctively, with occasional gleams of intelligence—thereby differing from man, who behaves emotionally with occasional gleams of intelligence. Major Hingston brings together much fascinating evidence to prove the existence of the gleams in insects. Perhaps as good a case could be made by a zealous ant for the existence of intelligence in man.

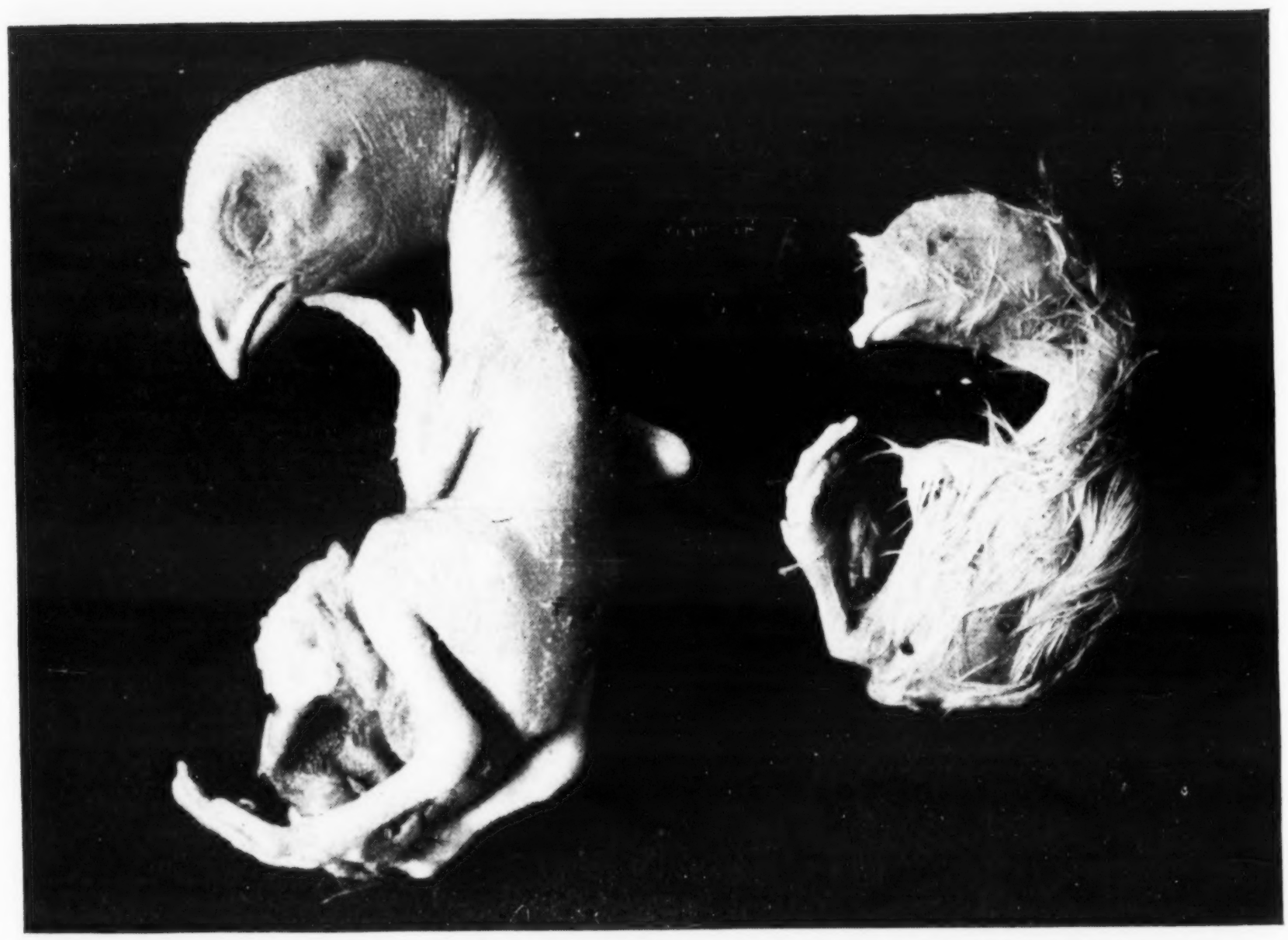
PROCEEDINGS FIRST COLLOQUIUM ON PERSONALITY INVESTIGATION, held under the auspices of the American Psychiatric Association, December 1-3, 1928. Pp. 102. Price, paper sixty cents; cloth $1.00. New York, 1929.

The psychiatrists and the social workers discuss at length why some of us *mis*behave like human beings. The volume is not indexed, but one gets the impression that heredity may have been overlooked. Perhaps a closer scrutiny would prove reassuring.

DAS PRINCIP GEOGRAPHISCHER RASSENKREISE UND DAS PROBLEM DER ARTBILDUNG, by BERNARD RENSCH, Zoological Museum, Berlin University. Pp. 208 Price 14.50 Reichsmarks. Illustrated. Gebruder Brontrager. Berlin, 1929.

DOWNLESS CHICKENS

A. S. Serebrovsky and S. G. Petroff
Central Genetical Station, Moscow, U. S. S. R.



DOWNLESS AND NORMALLY-FEATHERED CHICKS

Figure 10

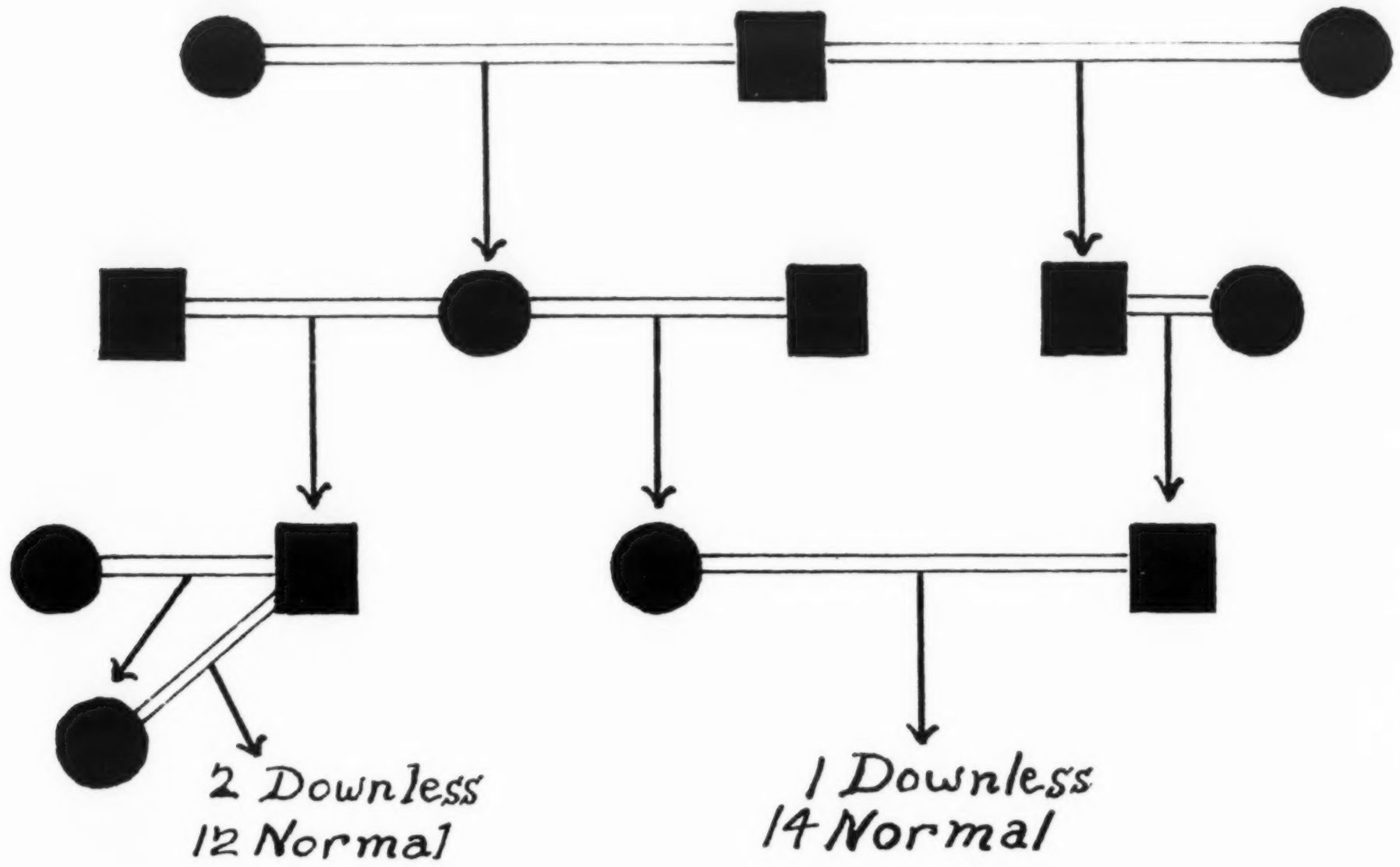
The normal chick is at a considerably earlier stage in development than the downless. Three chicks showing this peculiarity appeared in an inbred strain. None of them survived hatching, which suggests that the condition is semi-lethal.

IN 1926 a completely downless chick was observed at this Station. The chick had died before hatching but was fully developed and of normal size. The body was almost completely bare, only an occasional isolated down feather was to be seen. At the same time it showed another peculiarity, a very weak development of the scales on the shanks and digits, such as is characteristic also of recessive leg-feathering (*asuso**). The scales were separated by rather wide areas of skin.

The reduction of the capacity of the skin to form both feathers and their homologues, scales, led us to assume that a mutation had occurred. This was confirmed by an examination of the pedigree of the downless chick, which arose from the mating of two related individuals (Figure 11). Besides the downless chick this mating gave 14 normal ones, so that no simple Mendelian ratio was in evidence.

During the present year two more downless chicks were observed. One was completely downless; the other was sparsely covered with incompletely developed black down. Both had incompletely developed scales on the legs and had failed to hatch. The black chick, however, was alive when found.

* For an explanation of this system of nomenclature see *Journal of Heredity* 19:511-519. 1928.



RELATIONSHIP OF DOWNLESS CHICKS

Figure 11

The three chicks are closely related, which indicates that the condition is inherited. The ratio of downless to normal suggests that two factors are involved, but it is possible that other downless chicks died early in development, thus masking a 3:1 ratio characteristic of single-factor inheritance.

These chicks originated also from a mating of close relatives, which were also related to the parents of the first downless chick. (Figure 11).

The following three facts are to be considered:

1. Among 16,000 chicks hatched at this Station three showed the same abnormality.

2. The three downless chicks originated from matings between close relatives.

3. Both of the families in which downless chicks occurred belonged to the same pedigree.

These facts make it probable that this abnormality is not due to an external cause but to specific semilethal genes. We probably have to deal here with something more complex than a single lethal gene. The segregation obtained in the two families—25 normal, 3 downless—deviates too widely from the monohybrid scheme. The ratio resembles a 15:1. Possibly part of the downless chicks died early in development and thus escaped observation.

A RED-TO-WHITE MUTATION IN MAIZE

A Probable Somatic Mutation of the Gene for Red Pericarp in Maize*

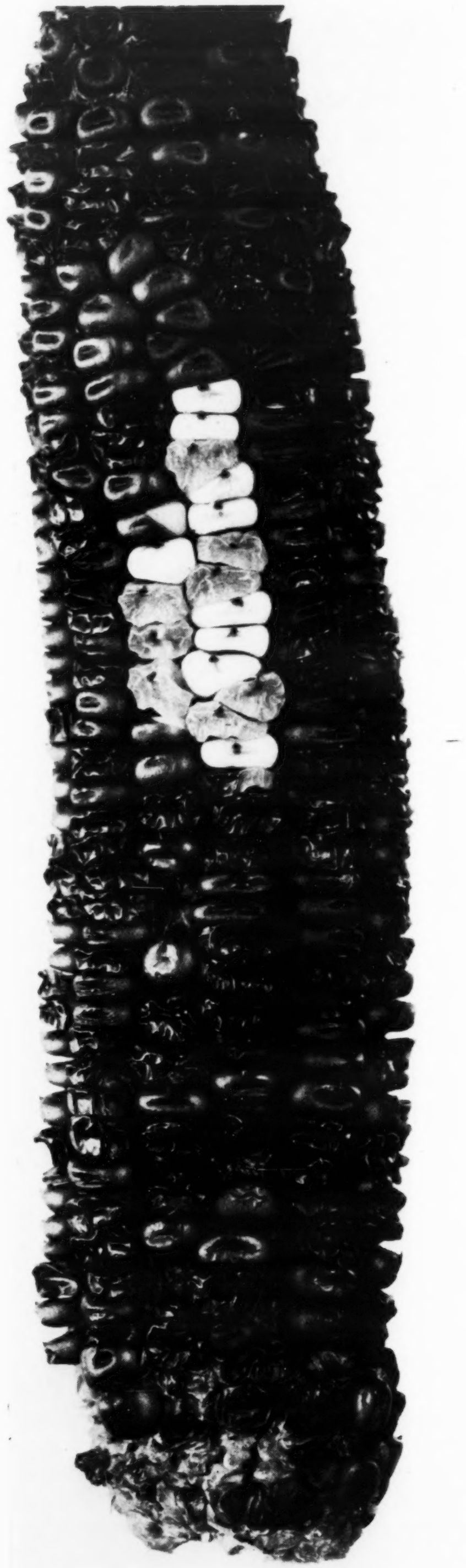
R. A. BRINK

Department of Genetics, University of Wisconsin, Madison, Wis.

THE unusual ear of maize shown in Figure 12 occurred on one of 128 plants in a progeny resulting from a cross between a stock homozygous for dark red pericarp and a line producing white seeds. The remaining individuals bore red ears as expected.

The character of the aberrant specimen is clearly shown by the photograph. The exceptional seeds are white save at the point of silk attachment. They occur in the central part of the ear in two adjacent rows. The area affected is about three per cent of the whole. The line of demarcation between the colored and colorless zones is abrupt and passes through three seeds at the edge of the white area. The cob color was red and was not changed under the white seeds. On one kernel, fourth from the top in the longer row of whites, a narrow band of red (not shown in photograph) extended down one side from the apex to the tip.

It happened that this particular ear was among those in the progeny which were bagged and crossed with a



A MUTATION TO WHITE

Figure 12

An exceptional ear occurring among the offspring of a cross between red pericarp and white pericarp lines. The ear is segregating for starchy and sugary endosperm, which causes the difference in the texture of the grains.

*Paper from the Department of Genetics, Agricultural Experiment Station, University of Wisconsin, No. 96. Published with the approval of the Director of the Station.

homozygous white stock. Ordinarily this type of mating would produce equal numbers of red-eared and white-eared offspring.

All the seeds on the two aberrant rows and most of those in the two adjoining rows were identified by numbers and planted individually. At maturity the plants were classified for pericarp color. The results of this progeny test are shown in Table I.

About one-third of the seeds in each class, red, parti-colored and white failed to produce plants bearing ears. In the two latter groups this was due wholly to non-germination. Among the 34 red seeds whose genotype was not determined, 26 failed to germinate and 8 gave barren plants.

The plants grown from the red seeds were of two classes, red-eared and white-eared. There are 5.5 ± 2.72 more whites than expected on the 1:1 basis but such a deviation should occur as a result of chance once in about six trials. The two parti-colored seeds which grew proved to be homozygous whites. The 11 plants from white seeds all bore white ears. Genotypically as well as phenotypically, therefore, all these seeds were white. When this latter distribution is compared with that calculated on the 1:1 basis we find a deviation of 5.5 ± 1.12 seeds. A deviation of this magnitude would result from chance alone only once in approximately 1,000 trials. It is highly probable, therefore that the change leading to the formation of white pericarp affected the embryos in like fashion and was consequently transmitted to the offspring.

Two hypotheses may be considered in accounting for these results, non-disjunction of the chromosome carrying the *P* gene and, secondly, mutation of *P* to *p* in somatic tissue. If the former were the explanation we should expect that the plants arising from the white seeds would lack one chromosome of the normal complement and, in consequence, would probably be partially sterile. Microscopic examination of the pollen of these individuals, however, and inspection of the ears they produced showed them to be fully fertile. It is unlikely, therefore, that the white area on the aberrant ear was due to an irregularity in cell division involving loss of the *P* chromosome in a part of the developing plant. The more probable explanation is that in the vegetative cell which gave rise to the white section of the ear the gene for red pericarp mutated to white.

Many pericarp color types are known in maize. Studies by Emerson*, Anderson† and others indicate that they are governed by a series of multiple allelomorphic genes. Some of the factors are unstable, notably those for variegation which mutate freely to lighter or darker variegation and to self red and to self white. The latter types, on the other hand, are very stable. The mutation from red to white described in the present paper is one of those which rarely occurs.

TABLE I—Distribution of plants with red and with white pericarp from red, particolored and white seeds on the ear shown in Figure 1.

Color of Parent Seed	Red		Particolored		White	
Color of Offspring	Red	White	Red	White	Red	White
Frequency	27	38	0	2	0	11
Failures	34=34.1%		1=33.3%		6=35.3%	

American Nat. 48:87-115.

†*Genetics* 9:442-453.

A PINK POINSETTIA CHIMERA

T. Ralph Robinson and Geo. M. Darrow

Office of Horticultural Crops and Diseases, Bureau of Plant Industry, U. S. Department of Agriculture

At the nurseries of the Reasoner Bros., at Oneco, Fla., in December, 1927, Mr. N. A. Reasoner called the writers' attention to a row of pink-flowered poinsettias (*Euphorbia pulcherrima*) in which a few of the shoots had produced pink and the rest red "flowers" (properly, colored bracts surrounding the flowers). During the previous winter these plants had been frozen back severely; following this they were cut back, leaving from six to eight inches of the stem above the ground. When observed, they had made a normal growth of new stems and were in full flower.

A census of the plants, 16 in number, was made with the following results:

Plant Number	*Number of Stems*	*Pink "Flowers"*	*Red "Flowers"*
1	3	3	
2	3		3
3	3	1	2
4	4	1	3
5	3	1	2
6	6	3	3
7	5		5
8	8		8
9	4		4
10	3	2	1
11	6		6
12	3		3
13	8		8
14	2		2
15	11		11
16	3		3
Total 16	75	11	64

Percentage of reversion—pink to red—85%

The plants in this row, showing pink and red flowers, bordered the west side of a walk or passageway between two of the greenhouses (Figure 13). A similar row of nine plants was growing on the east side of the walk, but these plants showed pink flowers only. Mr. Reasoner explained that these plants had not been frozen back so seriously, two or three feet of the stem having been uninjured in each case. These plants were also cut back to the same height as those in the other row.

The fact that no red flowers appeared on plants that had not been frozen back nearly to the crown, suggested the experiment of propagating by root cuttings from the pink, the pink and red, and the red plants. Mr. Reasoner offered to have this done, although he knew of no previous attempts to grow poinsettias by this method. Root cuttings from one-fourth to three-fourths of an inch in diameter and two to three inches long were placed in a rooting bed in one of the greenhouses (Figure 14). It was over a month before there was any sign of sprouting, but by February 17, 1928, about half the cuttings showed signs of sprouting, and on March 2 the following record was made: Four out of four "Reverted Red" rooted and growing; two out of four "Mixed Pink and Red" rooted and growing; five out of seven "Pink" rooted and growing..

Observations made on these plants from time to time showed no marked differences in their foliage, all the leaves having the purplish-red petiole and midrib associated with red-flowered plants, as contrasted with the pale colorless petiole occurring in leaves of the pink variety. On November 10, 1928, all these plants grown from root cuttings were in bloom and all showed normal red flowers. Also at this time a single plant of the row which the year before had borne only pink flowers showed one stem with red flowers; this stem, however, had started from below the crown of the plant where a root had been injured.

Mr. J. Wise Byrnes, Assistant in Charge of Gardens and Grounds, U. S. Department of Agriculture, kindly fur-

nished the writers several potted plants of the pink variety; these were cut back to heights of from ground level to six inches and then grown in the greenhouses in Washington. Though cut back in December, 1927, and January, 1928, they all flowered again before summer. Two plants which were cut back to the ground sent up shoots from slightly below ground-level which bore pink flowers but which had streaks of red tissue in the stems and in some leaf petioles. In the winter of 1928-1929 four of the same plants were again cut back to ground-level; of these, one died, two produced only green shoots, but the fourth produced one green shoot and one with red stem and petiole. Results in Florida and in the greenhouse indicate that is it possible to obtain novel plants with branches producing both red and pink flowers on the same plants by cutting vigorous plants back to ground level.

Mr. Byrnes found among his pink poinsettias in 1927 one plant bearing part pink and part red flowers (Figure 15). He also found one plant among his red poinsettias with paler or rose-tinted red flowers which had sported from the typical red form.

The experience with these poinsettias suggests the condition Bateson[1] found in Bouvardias and Pelargoniums; when grown from root cuttings the pink-flowered variety of Bouvardia (Bridesmaid) reproduced the red-flowered variety, Hogarth, and similar results were obtained with a number of Pelargoniums. He concluded that the pink was a sport from the red and that the plants were chimeras with a superficial layer of cells of the pink overlying a core made up of cells of the red type.

Shoots from root cuttings commonly originate from callus arising from the cambium. If the mutation involved only the superficial layers then a shoot from a root cutting should consist of the original form only and should reproduce the original type. Since the pink poinsettia behaves in this manner it is apparently a chimeral sport of the red and is of the same type of chimera as the thornless blackberry reported in this Journal in Volume 19.

The pink variety, however, is supposed to have originated with Albert Trebst of Merseburg, Germany, as a sport from the white. Unless the white itself is a chimeral sport of the red it is difficult to understand how the pink could have been derived from it.

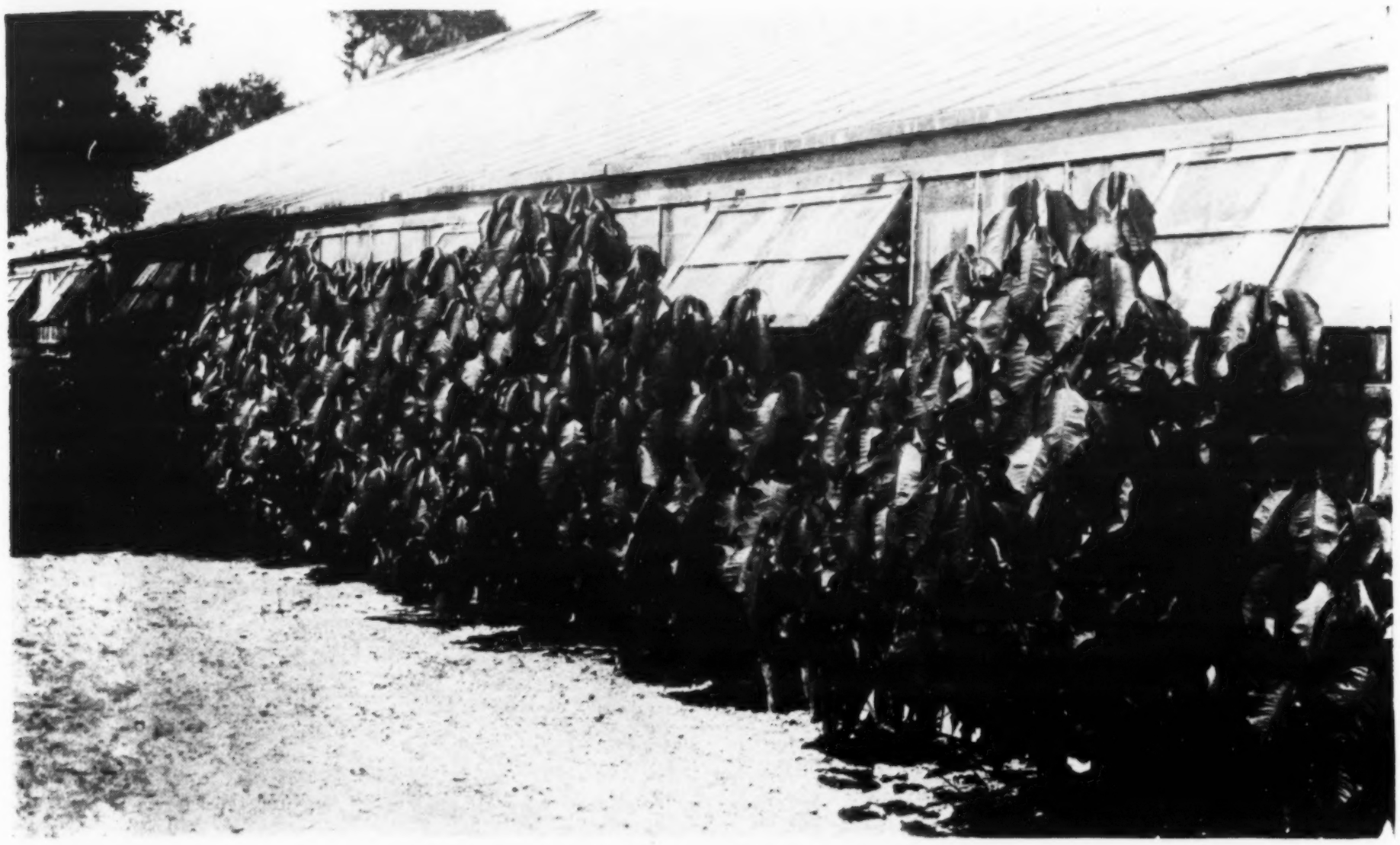
Root cuttings of the white poinsettia propagated by the Reasoner Bros., November 10, 1928, were already in leaf January 28, 1929. All these cuttings showed the pale white leaf petiole characteristic of the white variety, a result which confirms its supposed origin as a seedling of the red form. Moreover, a white poinsettia has recently been obtained as a seedling of the red form at the Reasoner Bros. Nursery.

History of Poinsettia Varieties

The red poinsettia is native to Mexico and was introduced from that country in 1828. In 1835 a white variety, *alba* or *albida*, and in 1872 a "double" form of the red, *plenissima*, was discovered in Mexico and introduced. Andre[2] in 1905 listed seven varieties besides *plenissima* as follows: (1) A bractees jaunes; (2) a bractees blanches; (3) rosea-kermesina; (4) major; (5) ignescens; (6) variegata; (7) variabilis.

Adnet[3] in 1913 listed three varieties of white poinsettias; two forms of *alba* and one of *lutescens*, a white with abundant leaves; by crossing the latter with the red he obtained a variety called *salmonea adneti*. A colored plate of this variety accompanying his article is not distinguishable from the pink of the Royal Palm Nurseries or the pink of Mr. Byrnes. Another variety, *rosea*, slightly lighter than the typical vermillion, has been known in England. A published colored plate of this variety[4] is apparently identical with the rose-tinted sport of the red found by Mr. Byrnes.

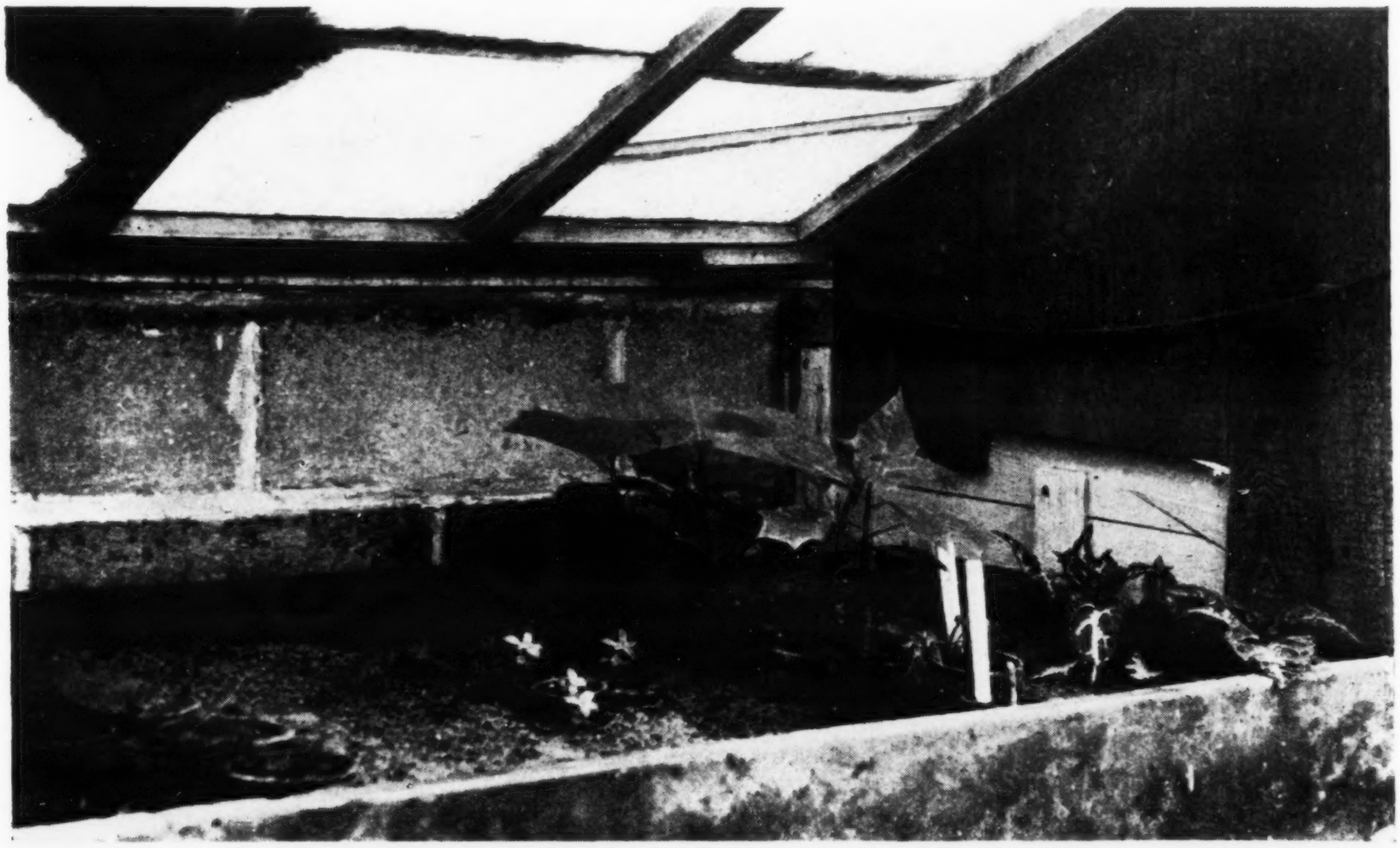
H. E. White[5] at the Missouri Botanic Gardens, has crossed the red, the



REVERTING POINSETTIA PLANTS

Figure 13

Row of pink poinsettias 85 per cent of which reverted from the pink flowering form to the red after being cut back by freezing in January, 1927. Reasoner Bros. Nursery, Oneco, Fla.



RED PLANTS FROM PINK ROOT-CUTTINGS

Figure 14

Root cuttings of "pink," "reverted red" and "mixed pink and red" poinsettias, growing in rooting bed at right. Reasoner Bros. Nursery, Oneco, Fla. The fact that these plants are red indicates that the pink form is a chimera, the pink being only one or more layers thick. The buds which differentiate from root cuttings are produced from deeper-lying "red" tissue, and thus the resulting plants are red.

A CHIMERAL PLANT

Figure 15

A pink-flowered poinsettia bearing part pink and part red flowers (properly, colored bracts surrounding the flowers) found by Mr. Byrnes in 1927. The pink is a chimeral sport of the red and in this case the red has again appeared.

pink and the white varieties with the following results:

Cross	*Color of Seedlings*
Red × Red	red
Red × Pink	pink
Pink × Red	red
Pink × White	pink

His results indicate that pink is apparently dominant over white but reciprocal crosses of red and pink did not give like results. Adnet has completed the series of possible crosses by crossing red and white to secure a pink.

Summary

1. The pink poinsettia used in these experiments is apparently a chimeral sport of the red.

2. The white is apparently a seedling sport of the red.

3. The poinsettia may be propagated by the use of root cuttings.

4. The production of novel red and pink "flowering" shoots on the same plants is possible by cutting vigorous plants back to the surface of the ground to induce buds from just below the ground level.

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5. The Poinsettia. *Mo. Bot. Gard. Bulletins* 13:143-148.

Watchful Waiting in Eugenics

EDUCATION of a considerable portion of any population in an unfamiliar movement is not easy. Human beings respond emotionally with conspicuous readiness, and to a subject like eugenics, demanding rigorous analysis of inalienable personal rights, the response is likely to be emotional opposition. Education must be gradual. Those who are able and willing to give careful consideration to such a movement should do so; they should also learn to distinguish between the careful decisions of well-informed scientists and the scientific quackery which is all too common in matters concerning the human race. No thoughtful eugenists would consider the wholesale regulation of marriages beyond protection against unfortunate consequences, yet the idea has gained a hold on the popular mind through various agencies that this is proposed by eugenics. Our knowledge of man is insufficient to accomplish the production of ideal types even if such a course were desirable. Many of the popular ideas of eugenics are myths which have had unjust and wholly unwarranted consequences.

The whole program of eugenics at present may be summed up as watchful waiting. Proposals of eugenic organizations recommend principally extensive research in all fields related to human heritage, education, both formal and popular, in heredity and eugenics, and a policy of delay in attempts to secure legislation in this field. Such a program is no more than the wise use of our intelligence in relation to ourselves.

Eugenics recognizes the importance of the heritage in man and proposes as an ideal goal the securing of an adequate heritage for every individual. The movement is young but it is even now possible to make positive proposals for the elimination of obviously unfit strains, such as mental defectives. The differential birth rate shows the need of eugenic measures in all classes of society, since the lowest classes are the most prolific and educated classes do not maintain themselves. In this field, however, nothing but sound education is at present possible. The program of eugenics therefore urges continued investigation, extensive education, and only such legislation as progress warrants.—Lindsey, A. W., *Textbook of Evolution and Genetics*. Pp. 383-4. Macmillan Co. New York, 1929.

Photograph by H. F. Loomis.

HAIRY BOLL OF HYBRID COTTON

Figure 16

A boll of the Pima × College F_2 plant on which the pubescent character was first observed. In order that the hairs might be made to show more clearly in the photograph, the boll was exposed to the mixed fumes of ammonia and hydrochloric acid, which caused the disposition of a white film of ammonium chloride on the hairs. Magnified about 5½ times.

HAIRY BOLLS AND NECTARIES IN A HYBRID COTTON

By Robert H. Peebles

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CROSSES between plants of the Pima variety of Egyptian cotton and the College variety of Upland cotton were made in 1925, at the U. S. Field Station, Sacaton, Arizona. First generation progenies were grown in 1926 and second generation progenies in 1927. The latter showed the pronounced segregation in many characters which always appears in F_2 of hybrids between these very distinct species of *Gossypium*.

A plant in one of the Pima × College F_2 progenies was characterized by extreme hairiness. Pubescence occurred on the stems, leaves, stipules, pedicels, outer surface of the involucral bracts, margin of the calyx, floral nectaries, corolla (the portion exposed in the bud) and outer surface of the bolls. There was also a pronounced development of hairs on the inner surface of the bolls, along the sutures. The hairs of the calyx margin were mostly branched, while those on the outer surface of the boll were mostly simple.

A lesser degree of pubescence on most of these organs occurs in many cultivated cottons, including both parents of this hybrid, and exaggeration of the hairiness in one of the segregates is not surprising. The plant here described is unique, however, so far as the writer's experience goes, in the dense, woolly pubescence of the floral nectaries, in the conspicuous hairiness of the outer surface of the bolls and in the marked development of intra-carpellary hairs.

Flowers were "selfed" on the F_2 plant and an F_3 progeny of six individuals was grown in 1928, in which these three peculiar characters seem to be of sufficient morphological interest to justify brief description at this time.

The nectaries, three in number, situated at the base of the outer surface of the calyx, are broadly triangular in outline, with the apex of the triangle inverted. The surface of the nectary is covered with a felt-like mat of hairs, as shown in Figure 17. In most cottons the nectaries of the calyx are smooth or only slightly pubescent.*

All six of the F_3 plants had the outer boll surface hairy, as was the case in the F_2 parental individual (Figure 16). The hairs were rather evenly distributed, mostly unbranched, somewhat rigid and about 0.6 millimeter in length. They are longer and more numerous along the sutures of the boll than elsewhere. In the Pima variety, there are traces of similar pubescence on the ovary, but the hairs disappear long before the boll matures. (Figure 18).

It may be conjectured that Pima carries a factor for boll pubescence but that development of the character in the mature boll requires the presence also of a modifying factor which the hybrid received from its Upland parent. But, as pubescent bolls have not been observed in the College variety to which the Upland parent of this hybrid belonged, it is inferred that this parent lacked the primary factor and possessed only the modifier.

Intra-carpellary hairs are found in several genera of Malvaceae, including Gossypium.[5] They are well developed in Thurberia, a shrub or small tree nearly related to cotton, which grows

*It was mentioned by Cook, McLachlan and Meade[3] that in Mit Afifi Egyptian cotton "the internal nectary of the calyx is usually accompanied by a rather indistinct band of hairs along its upper margin. . . . . Upland cottons have a very distinct ring of hairs surmounting the internal nectary, in some cases quite prominent."

Photograph by H. F. Loomis.

A HAIR-FILLED NECTARY

Figure 17

Nectary at base of calyx, on a young boll from an F_3 plant of a hybrid between Pima Egyptian and College Upland cottons. The nectary, broadly triangular in outline with inverted apex, is filled with matted hairs resembling wool. Magnified about 8 times.

Photograph by H. F. Loomis.

TRANSIENT HAIRS ON OVARY

Figure 18

Ovary of a Pima cotton flower at time of anthesis, showing traces of pubescence which disappear in the early stages of boll development. Magnified about 5 times.

wild in southern Arizona and Mexico. (Figure 19). Gray describes the origin of these hairs in Thurberia as follows: "A nearly complete, but thin and delicate, spurious partition, projecting from the back of each cell . . . as the ovary enlarges after anthesis, is soon broken up into long and delicate horizontal shreds or hairs, that persist even in the ripe pod, stretching from the dorsal suture almost to the axis, between the two rows of seeds."[4]

Gray's account of the origin of these structures would indicate that they are not true hairs—outgrowths of epidermal cells. When examined under the microscope, however (Figure 21) they are seen to be one-celled, and this fact excludes the possibility of their having originated by fragmentation of a partition. Although the development of the intracarpellary hairs has not been studied, it is highly probable that they are extensions of epidermal cells, hence similar in origin to the lint hairs of the cotton seed, which they considerably resemble.

The occurrence of intra-carpellary hairs in cotton (Gossypium) apparently was unknown to Watt, since he mentions this as one of the characters distinguishing the genus Thurberia from Gossypium and other genera of the Hibiscus tribe.[6]

The first observation of intra-carpellary hairs in a true cotton, so far as the writer knows, was made by O. F. Cook on a plant at Somerton, Arizona, in 1909, which apparently was a hybrid between an Egyptian cotton and the Upland-like form known as "Hindi." Mr. Cook states:[1] "The empty carpels of this plant showed a further peculiarity not hitherto observed. The ridge that marks the middle of the wall of the carpel, the line of dehiscence of the ripe fruit, gave rise to a series of long slender hairs that projected into the cavity. Hairs of the same kind were found afterwards in normal plants [of Egyptian cotton?] and may be looked upon as an additional storm-proof character, since they undoubtedly help to hold the lint and seeds in place after the carpels have opened." Lewton[3] mentions *Gossypium harknessi,* a truly wild cotton of lower California, as possessing this character.

The writer has observed the occurrence of intra-carpellary hairs in Sea Island cotton and in Pima and other varieties of Egyptian cotton (Sakellaridis, Ashmuni, Zagora, Assili, Pilion). In Pima, there is a fringe of short hairs on the inner surface of the carpel wall, attached to the intruding ridge of the false partition along the line of dehiscence. After the capsule has opened the hairs are seen as fringes or tufts along the edges of the valves. The development of these hairs was much

INTRA-CARPELLARY HAIRS OF HYBRID

Photograph by Robert L. Taylor.

Figure 20

At left: Single valves of bolls, one from each of the six plants of Pima × College F_3, showing the marked development of intra-carpellary hairs which is one of the striking characters of this hybrid. *At right*: Open bolls, with seeds removed, one each from a plant of Pima Egyptian cotton (lower left) and two F_2 plants of the hybrid Pima × Acala Upland. Natural size. The intra-carpellary hairs along the edges of the valves are seen to be more numerous and longer in the hybrid than in the Pima parent. The Pima boll has just opened and the edges of the valves had not yet begun to roll back.

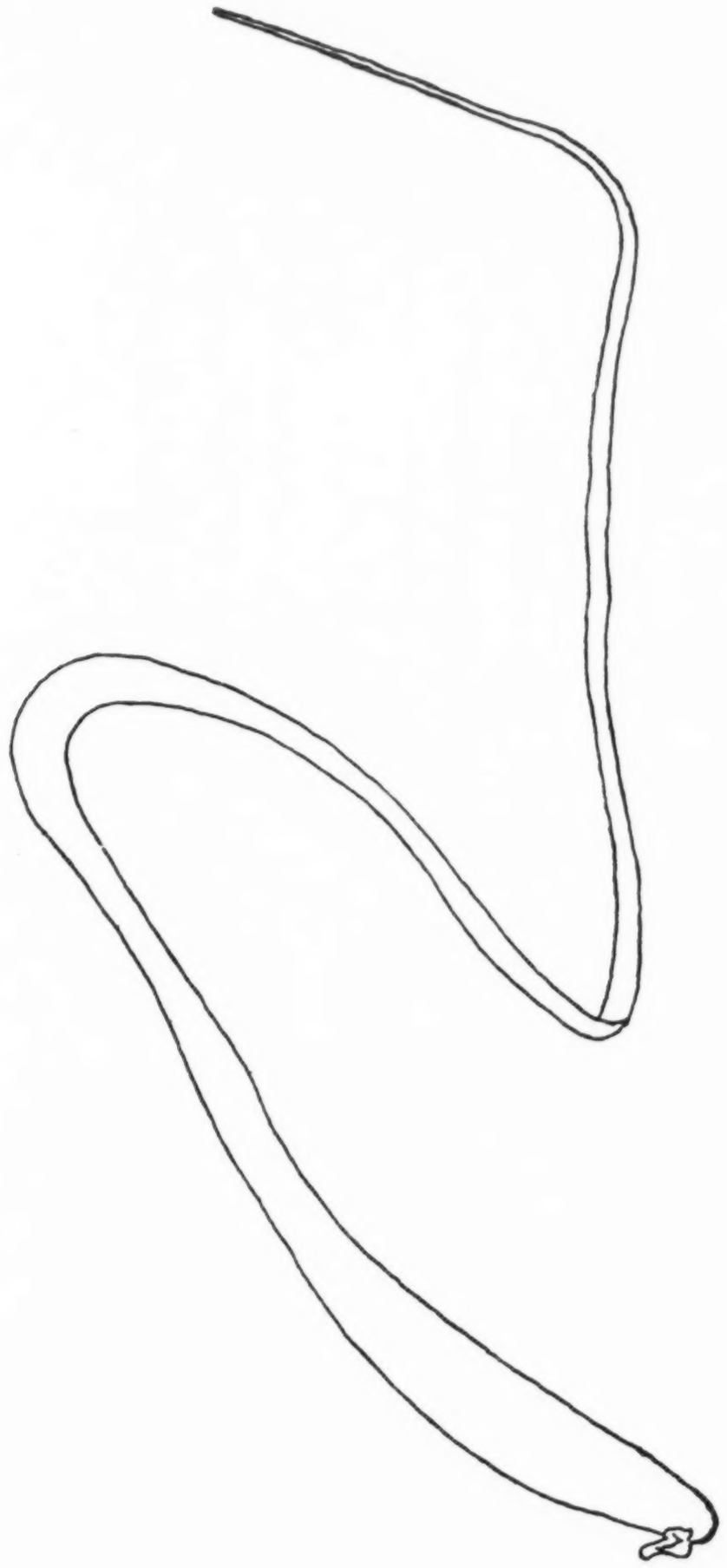
Pima Egyptian cotton (lower left) and two F_2 plants of the hybrid Pima × Acala. Note that the edges of the valves are seen to be more numerous and longer in the hybrid than in the Pima parent. The Pima boll has just opened and the edges of the valves had not yet begun to roll back.

Photograph by Robert L. Taylor.

HAIRS ON INSIDE OF CARPEL

Figure 19

A pod of *Thurberia thespesioides*, a plant nearly related to cotton (Gossypium), which grows wild in southern Arizona and Mexico. The three carpels or cells of the pod are shown. Note the soft white hairs along the edges of the carpels. Magnified 6 times.



HAIR FROM INSIDE OF BOLL

Figure 21

An intra-carpellary hair from a boll of Pima cotton, drawn with the camera lucida and enlarged 65 times.

more pronounced, however, in the Pima Egyptian × College Upland F_2 plant and in its offspring. All six of the F_3 plants of this hybrid showed the character conspicuously (Figure 20). Examination of the intra-carpellary hairs of the hybrid showed them to differ from ordinary seed hairs (lint) in their shorter length and greater basal diameter, the latter diminishing rather rapidly to a finely pointed apex.

In Upland cottons, dense fringes of hair occasionally are seen on the edges of the valves of the capsules. These hairs, however, are indistinguishable in character from the lint and probably originate in the same manner, as outgrowths of the epidermis of the seeds. The fringes usually are accompanied by an abnormal condition of the carpel wall along the ridge of the false partition. In unopened bolls this abnormal condition is seen as a discolored, spongy mass of tissue, and it is supposed that the seed hairs became embedded in or adherent to this tissue some time previous to the opening of the boll. In certain varieties of Upland cotton, for instance Acala, so much of the lint often adheres to the rough edges of the valves, as well as to other parts of the capsule, as to give the appearance of a carpellary fringe. This may be the condition in the Mexican cotton, *Gossypium contextum*, described by Cook

From a micro-photograph by Dr. A. E. Longley

HAIRS RESEMBLING LINT

Figure 22

Intra-carpellary hairs of Thurberia (basal portions), magnified about 350 times. The resemblance to the lint hairs of cotton seeds is rather striking.

and Hubbard, regarding which they conclude, "thus it is not certain that the attached fibers have actually grown from the walls."[2]

What we may term the false intra-carpellary hairs of Upland cottons are an important factor in the retention of the seed cotton in the open boll, whereas the true intra-carpellary hairs of Sea Island and Egyptian cottons play an unimportant rôle in this matter. Normally, in Pima, the valve edges roll outward and backward soon after the boll opens, the intra-carpellary hairs being carried quite out of the way of the lock of seed cotton, except at the very base of the cell.

In some of the F_2 segregates of a hybrid between Pima Egyptian and Acala Upland cotton, the development of intra-carpellary hairs was found to be more pronounced than in Pima. (Figure 20.) Two F_2 progenies of this cross were examined in 1927. The work was done late in the season after all of the bolls had been open for several weeks following a killing frost. The individuals were placed doubtfully in two classes—"hairs present" and "hairs absent, or nearly so." For the two progenies as one array, the ratio was 28 present; 4 absent. In 1928 bolls were examined on 119 plants belonging to two Pima × Acala F_2 progenies and intra-carpellary hairs were found on 113, the development varying from a very few hairs to well-developed fringes. None of these hairs could be found on the remaining six plants, although practically all of the bolls on these individuals were examined carefully with a hand lens. Considering the two progenies as one array, the ratio was 113 present; 6 absent. This is close to the 15 : 1 Mendelian ratio expected when two factors are involved, the calculated numbers being 111.6 present; 7.4 absent. χ^2 is .283, indicating nearly even chances that the departure is a result of random sampling.

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NORMAL AND ABNORMAL BRANCHING

Figure 23

(A) Normal method of branching in *Ailanthus glandulosa.*

(B) A normal branch half cut away to show the relation of pith between stem and branch.

(C) Abnormal branching in *Ailanthus glandulosa.* Transverse sections show the continuous pith.

ABNORMAL BRANCHING IN AILANTHUS

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THE normal method of branching in *Ailanthus glandulosa*, Desf. (*A*, Figure 23) is forked and irregular. The large pithy area in the center is not continuous between stem and branch; an intervesing area is occupied by the wood. (Figure I, *B*, shows a normal branch half cut away to show the pith relation between stem and branch.

The abnormal method of branching (*C*, Figure 23) is not forked and irregular, but is fan-shaped, flattened, and regular. Both (*A*), Figure 23 (normal branch) and (*C*), Figure 23 (abnormal branch) were cut from the same tree. The tree was about twelve feet in height and in a healthy condition. The normal branch was cut near the top of the tree while the abnormal branch was a side shoot near the base. The entire length of the abnormal branch was 42 inches. Progressing from the base upward, the abnormal structure flattens more and more, until at the apex seven distinct stems can be observed. The top had "died-back" so it was cut off before photographing. It can be observed, however, from the crotching at the apex, separating two stems from the remainder, that a tendency toward normal branching had taken place. The "dying back" may have been caused by this condition. The transverse sections show clearly that the pith is continuous throughout the flattened structure; differing in this respect from the normal condition. The leaf scars which appear aboundantly and close together on the flattened surfaces indicate beyond doubt that this condition is not simply a flattened stem, but is an abnormal method in branching.

This abnormal method of branching differs so greatly from the normal that occuring as they both do on the same tree, it is safe to consider the abnormal branch not simply a flattened stem, but a true vegetative mutation (bud sport).

Making the Most of the Microscope

Handbook of Microscopical Technique, C. E. McClung, Editor. xiv + 495 pp., 43 ills. Price, $8.00. Paul B. Hoeber, Inc., New York.

This important volume is, in a way, supplementary to two recent works, *General Cytology*, and *Special Cytology*, which have appeared under the editorship of Dr. E. V. Cowdry. In the earlier texts of the series, various experts have summarized the results of recent investigations in the field of cytology. The present work gives us the latest word in respect to the methods employed in these and similar studies.

Like its predecessors in the series, this book is a cooperative effort. It has been produced under the editorship of Prof. C. E. McClung, one of our foremost authorities in matters of technique, as well as the leader of one of the most significant groups of cytological investigators of the present day. He has had the cooperation of more than a score of well-known authorities, who have contributed chapters bearing upon methods in their particular fields of study.

This is by no means a text-book for elementary students, although as a reference work, it will be of undoubted value, even in this field. Nor is it a mere compendium of materials and

methods. In this direction, it can hardly lay claim to exhaustiveness. It is rather a series of essays, independently written, sometimes at variance in certain respects, each dealing with a particular field, and written by one who has had much to do with the development of that field. The reader is constantly given the benefit of the experience and mature judgment of the author, and is not left to flounder through a compilation of methods without guidance. A certain necessary and desirable bias is in evidence in certain of the articles, and constitutes one of the chief assets of the book. When differences in point of view lead to contradictions, these are for the most part taken care of by a careful system of cross references, so that one may have the benefit of more than a single judgment.

The contrast between such a volume and one which is merely a compilation of suggestions, most of which have been culled from the literature, is very great. In this work, many of the techniques that have had a revolutionary effect upon modern research are described by their own inventors, or foremost advocates. A discussion, for instance, of microdissection by Prof. Robert Chambers, or of bacterial methods or the uses of the various analine dyes by Prof. H. J. Conn possess a degree of authoritativeness and accuracy not to be expected in the second hand accounts of compilers. Herein lies the chief value of the book.

The volume will be helpful to cytologists, histologists, pathologists, bacteriologists and embryologists, to both botanists and zoologists, and to workers in the applied fields of medicine and dentistry. It will be of special benefit to those who find themselves confronted with the necessity of applying in their work new and unfamiliar tests, in using types of techniques in which they have had no previous experience.

Part I of the book is devoted to a rather brief review of general methods. Part II deals with special methods. The topics considered are: Methods for the study of fresh material, including microdissection, microinjection, and the use of vital and supravital stains; bacterial methods; general botanical microtechnique, both histological and cytological; cytological methods, including a section devoted to mitochondria and the Golgi apparatus; embryological methods; histological methods, as they relate to a variety of animal and human tissues, and protozoological methods. There are, finally, three important chapters treating of fixations and fixatives, stains and staining, and miscellaneous suggestions. It will be seen from this list that the field covered is a broad one. The wonder is that the outstanding characteristic of the book is not superficiality.

It is rather surprising that a book of this size, relatively deficient as it is in illustrative material, should be so costly. It is to be feared that this will somewhat limit its usefulness. In the field of microscopical investigation, accuracy of result depends largely upon the quality of the technique employed. Nevertheless there are many investigators publishing today who do not know a really first-class preparation from a bad one, with serious consequences to the validity of their observations. There is need that the gospel of better technique and more refined methods which permeates this book be spread as far and as widely as possible. Anything that is calculated to hinder in any way the widespread use of the book must be regarded in the nature of a misfortune.

Ralph E. Cleland.